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The International Journal of

Orthodontia, Oral Surgery and Radiography

Vol. XI St. Louis, January, 1925 No. 1

ORIGINAL ARTICLES

ORTHODONTIA ALLOYS*

By Reginald V. Williams, Buffalo, N. Y.

IT was said in regard to my paper on gold-platinum alloys, given last year, that I went into the subject too abruptly and without sufficient preliminary explanations and that I did not convey a clear understanding of the various terms and definitions which I used.

The following expressions are often heard: "I like this wire because it is tough." "I like it because it is peppy." "I prefer this material because it stays put." All of these qualities may be expressed in proper terms and are definitely measurable.

Most of the materials used by the orthodontist are alloys. In order to study the properties of an alloy, one or all of three general methods may be employed. The first method is by studying the cooling curves or equilibrium diagrams and the process is briefly as follows: All of the component metals of the alloy are placed in a crucible and melted. A thermocouple having a pyrometer attached is placed into this molten metal. The metal cools at a uniform rate until it solidifies or a chemical change takes place. Here heat is given off or absorbed and a break takes place in the uniformity of the cooling curve.

This may sound quite technical and of no practical value, but it is not so, as will be shown when the cooling curves are examined. When the cooling curves are examined, it is possible to determine:

1. If the metals are completely miscible and soluble in each other forming a homogeneous liquid, as is the case in most industrial alloys.
2. If the metals are partly miscible.
3. If the metals are completely soluble.

*Read before the American Society of Orthodontists, Kansas City, Mo., March 18-21, 1924.

A second general method of studying the properties of an alloy is by microscopic examination of the structure after solidification. In this connection great credit is due to the cooperation received from Professor David E. Waite of the University of Buffalo.

A third general method of studying the properties of an alloy is by mechanically testing the solidified metal. Of course, the actual test of the metal itself in the use for which it is intended is another method but this requires a considerable period of time in order to determine the conclusions.

Research in orthodontia alloys is extremely interesting. It probably represents the most difficult and intricate branch of dental metallurgy, and with casting golds is the biggest problem in this particular field. In spite of the technical phase of this work, the thermometric measurements, the photomicrographs, and mechanical test diagrams all have their practical values. In fact, so much so, that it has been decided by the University of Buffalo to give the students instruction along this line and have them actually conduct tests as part of their dental metallurgic course. For the sake of clarity, a few words will be said about the more important definitions.

What is meant by hardness? Hardness is ability to resist penetration and is really a form of strength. It is not a definite value. It is more often a comparative thing taking certain things as a standard and is determined by several well-known methods which will be illustrated later.

Tensile strength is the weight or force required to break a material into parts. It is a definite, not a comparative measurement, and is usually expressed in pounds per square inch.

Elastic limit is the weight or force that a material is able to withstand without undergoing permanent deformation.

Elasticity is the ability after deforming, of being able to recover to an original size or shape.

Springiness and elasticity are related. There is a direct relationship between elasticity and elastic limit and the latter is a standard measurement usually expressed in pounds per square inch.

At this point comes up a very fine distinction in the metallurgic requirements of the orthodontist and it can best be illustrated by the following example. Assume that there is a rod of metal fixed between two jaws in a tensile testing machine and that the rod is to be pulled apart. Assume also that the metal has a tensile strength of practically 100,000 pounds per square inch. Upon testing, it is found that the metal does not start to stretch until there has been exerted a strain of about 90,000 pounds per square inch. The point at which the metal starts to stretch is its yield point or commercial elastic limit. If sufficient weight is applied so as to exceed the elastic limit ever so slightly, the metal will not recover its original shape when the weight is removed.

In certain wires, the orthodontist requires springiness and in all of the wires it must be possible to accomplish a permanent bend. To accomplish a permanent bend, the elastic limit of the metal must be exceeded. If the elastic limit of a metal is 90,000 pounds per square inch and its tensile strength 100,000 pounds per square inch, to accomplish a permanent bend would seem

then that a stress must be exerted equal to nine-tenths of its total strength. This, however, is not true because the strain in bending is not longitudinal nor with equal stress on every crystal across the diameter of the wire. Bending is the combination of forces and is quite different from longitudinal strain as will be shown later. There is, however, a relationship in all of the physical properties of a metal no matter how it is deformed.

Last year, I stated that the ideal wire for orthodontia should possess maximum tensile strength and yet have sufficient torsional qualities for its particular purpose. Ideal wires should possess high tensile strength but the elastic limit should be kept within a limit of safety. Tensile strength and elastic limit are definite but in the work of the orthodontist they are very elusive qualities. Very little cold-work or thermal treatment will change these properties to a large degree.

The question as to what should be the tensile strength and elastic limit of the different metals used in orthodontia is a very difficult one to answer, due to the fact that the requirements vary so greatly and the technic is subject to so many variables.

If the length of the metal is accurately measured before testing for tensile strength, the percentage of elongation can be determined and elongation is one of the most important properties of orthodontic metals. Percentage of elongation is merely the amount that the metal stretches before breaking. Another measurement is that known as reduction of area and is the amount that a metal contracts at the breaking point. It is also measured in percentage. Both of these factors give measurements of ductility.

If the above points are kept closely in mind, there should be no difficulty whatever in understanding the tests as they are made. Last year I showed a number of photomicrographs with no preliminary explanation whatever, overlooking the fact that there might be some difficulty in understanding the interpretations.

The preparation of the sample is briefly as follows: if the particular metal or specimen is too small for convenient handling, either for the purpose of polishing or placing on the stage of the microscope, then it must be imbedded in some material that will hold it firmly in position. The imbedding of the sample is somewhat similar to the setting of a small precious stone in a ring. This mounting can be done very conveniently in lead or other soft material. Dental rubber is almost ideal. The specimen may be imbedded in the soft rubber and the entire mounting vulcanized. Care must be used in vulcanizing not to exceed the transition temperature of the metal under observation. Now that a convenient method is devised for holding the sample, the entire surface may be ground and polished, which at the same time prepares the specimen for observation.

The technic of polishing without scratching the surface, requires considerable skill. The specimen is subjected to a series of polishing or lapping wheels, the final finish being on broad-cloth, using the finest levigated rouge. The specimens are examined under two conditions—unetched and etched.

If examined unetched, the crystalline structure of the metal cannot be observed but the gaseous formations, blowholes, intrusions, cracks, or pits

can be seen to a much better advantage. It is certainly better for a beginner in this work to limit his observations to unetched specimens. He will then not be so liable to make wrong interpretations.

By etching, is meant attacking the surface of the specimen with acid or other reagent. Electrolysis is sometimes used. This procedure exposes the crystalline structure.

By examining the crystalline structure we get information as to the homogeneity of the metal. If the structure does not appear uniform in all

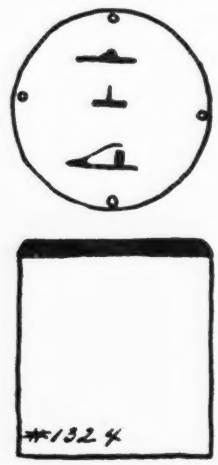


Fig. 1.—Method of mounting small specimens for microscopical examination.

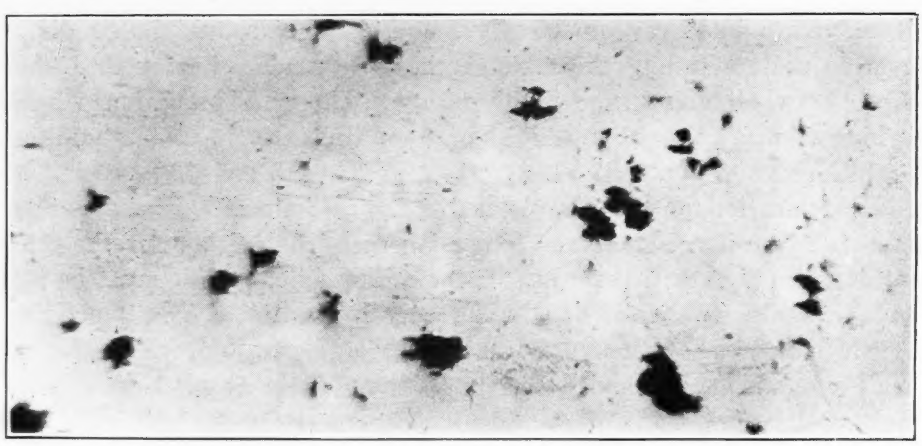


Fig. 2.—Unetched metal showing blowholes.

parts of the field, a segregation of one or more of the component metals has taken place. Also by examining the crystalline structure a certain amount of knowledge can be gained as to the chemical composition, method of manufacturing, method of heat treatment and other information that it is not necessary to mention in this paper.

Fig. 1 shows specimens mounted for observation. The holding media consists of a small block of wood, to the top of which has been nailed a small section of sheet lead. The nails are countersunk and covered. The specimens are imbedded in the lead and the whole surface filed and polished. It

facilitates matters if several specimens are placed in lead and all prepared in one operation.

Fig. 2 is a photomicrograph of an unetched casting. The dark irregular spots are blowholes. Sound metal, of course, should not contain blowholes. Sound, unetched metal would show simply a plain white field.

Fig. 3 is a photomicrograph of an etched and sound gold-platinum alloy. In this instance, it is very uniform. Any part of the alloy structure is similar to any other part. It was known that this metal was sound before mounting for examination. It tested very high in the tensile machine and had proper elongation. The same mechanical testing showed that the metal in the previous illustration was defective. The microscope does not offer a complete solution to all metallurgic difficulties, but in many instances, it merely verifies and explains information obtained from other sources.

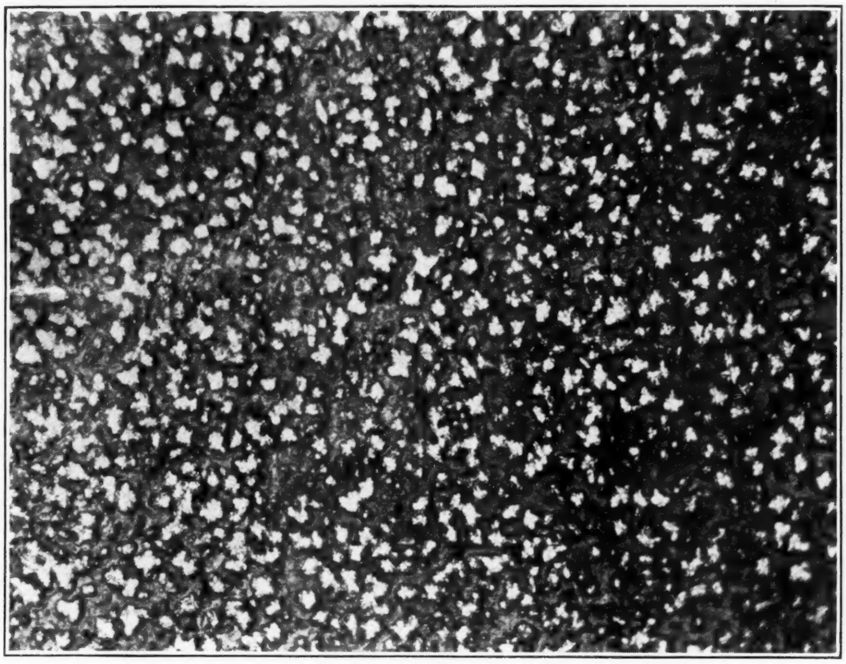


Fig. 3.—Etched and sound complex gold-platinum alloy. Structure very uniform.

Fig. 4 also illustrates a sound complex gold-platinum alloy, but in this instance it has been subjected to cold-work by being drawn into wire. The more or less rounded crystalline groups of the previous illustration have now a compressed, elongated appearance. The field is quite uniform, and there is no segregation or blowholes. A metallographist of considerable experience with this class of alloys, could tell the approximate tensile strength of this metal, also the heat-treatment to which it has been subjected.

Fig. 5 illustrates another type of structure found in complex gold-platinum alloys. It is the typical casting or dendritic formation and is the result of quickly chilled metal that has not been subjected to any annealing or cold-work. The peculiar lattice formation is caused by the simultaneous cooling of the metal at various points or nuclei. On annealing, this structure disappears.

Until considerable experience has been gained in metallographic work, it is better to rely more upon mechanical tests. When properly handled, however, the microscope cannot be criticized any more than the mechanical tests.

There is a well-known instrument for the determination of hardness known as the scleroscope. The principle consists in the dropping from a fixed height of a small hardened hammer contained in a graduated glass tube upon the metal to be tested. The higher the rebound of the hammer, the harder is the metal. This small hammer can be dropped on a piece of steel and it will rebound, say, half way up the tube. The same hammer can be dropped on a cork and it will probably rebound to the top of the tube. Almost all known methods of testing possess certain defects and are subject to

Fig. 4.—Metal shown in previous illustration after being cold worked or drawn into wire.

certain criticisms. This only emphasizes the fact that in all of this work there must be a coordination of knowledge, experience, and common sense.

On passing through the storage yard of some automobile plants, one might see piled up and rusting in the rain and snow a great accumulation of apparently old cylinder castings. These, however, might be an accumulation of new castings that have never been used. They are being allowed to age, or mature. This means that in some way or other, these castings change in their physical properties. They are not in condition to be used when immediately cast.

A question quite properly asked last year at Chicago by John V. Mershon was, whether the essayist had kept in mind the secretions of the mouth and the effect that they might have on the metals after being in the mouth for a

long time. With the cooperation of Walter H. Ellis, an attempt has been made to answer this question.

Ellis was provided with two lengths of spring wire. One was heated to redness and cooled in the air and the other was heated to redness and plunged hot into acid. The wires were not bent, soldered or manipulated in any way.

Fig. 5.—Dendritic or typical casting structure.

Fig. 6.—Method of carrying test wire for purposes of observing any physical changes through exposure in the mouth.

Several of these test wires were carried in the following manner by patients of Ellis.

Fig. 6 shows a round tube which was soldered to and under the lingual arch. The test wire was inserted into this tube.

Fig. 7 demonstrates the annealed wire that was used in the experiment. The general uniform structure is observed and, of course, the cold-work appearance. The structure, as a whole, is a series of straight lines or interrupted straight lines and is characteristic of these particular air-cooled alloys.

Fig. 8 shows a spring wire of the same alloy that has been heated to redness and plunged while hot into dilute acid. The structure is still quite uniform but the straight line appearance has been broken up. This structure is characteristic of these alloys when heated to redness and plunged hot.

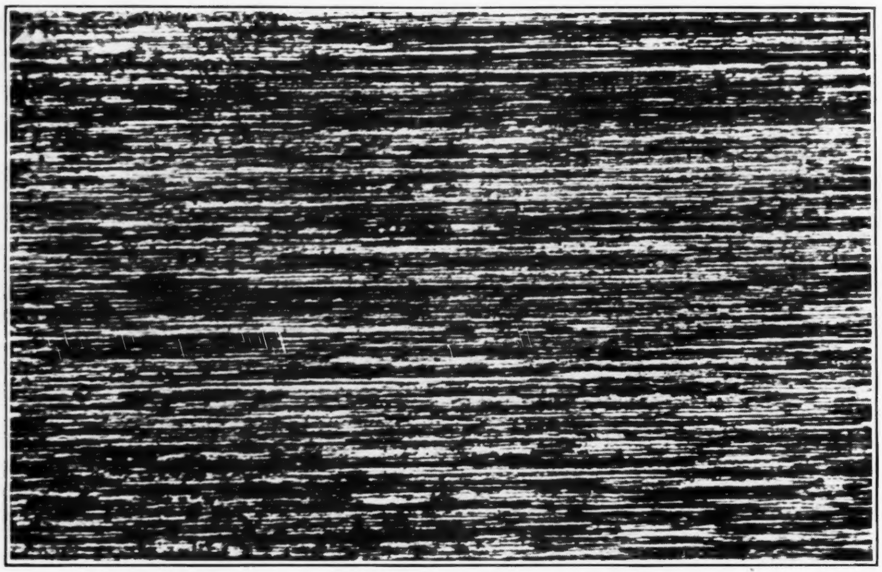


Fig. 7.—Test wire that had been heated to redness and allowed to cool in the air.

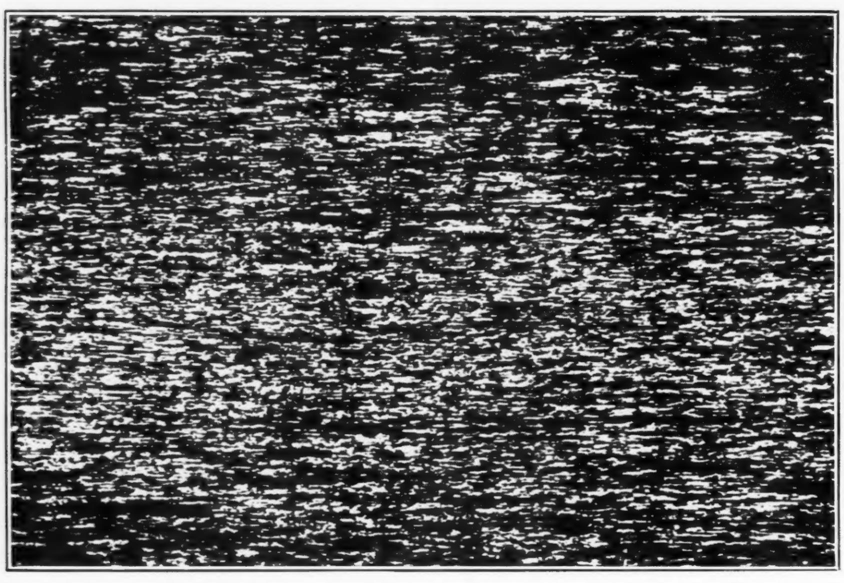


Fig. 8.—Test wire that had been heated to redness and plunged hot into dilute acid.

Fig. 9 shows the wire after two months' exposure in the mouth. The lower part of the photomicrograph is slightly out of focus but there is no difficulty in distinguishing the particular metal. It is the wire that has been heated to redness and allowed to cool in the air.

Fig. 10 shows another test wire after three months' exposure in a different patient's mouth. From the structure it is easy to detect the hot plunged wire.

In conclusion and in answer to Mershon's question, it can be stated that no perceptible change was found in any of the spring wires, after two, three, and eight months' exposure in the mouth. If the wires harden, or there is any change in the physical characteristics while in the mouth, it is probably due to manipulation or cold-work either by the orthodontist or the patient. Conditions of acidity or alkalinity were tested by Ellis and in all cases were found to be neutral.

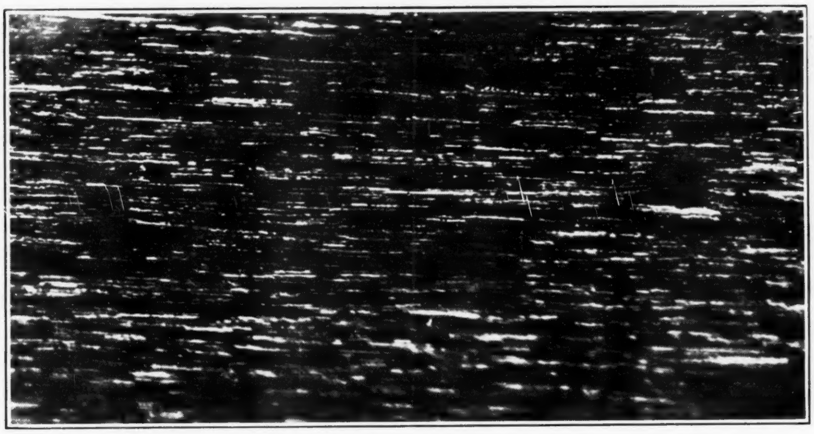


Fig. 9.—Air cooled test wire after two months' exposure in the mouth.

Fig. 10.—Hot plunged test wire after three months' exposure in the mouth.

BREAKAGE OF LINGUAL ARCH WIRES

This investigation was also carried out with the cooperation of Walter H. Ellis.

It is evident that most of the breakage has been occurring at a particular section of the arch. The investigation was conducted on broken and mended arches.

Fig. 11 is a diagram of the appliance. The circular dot marks the spot at which the appliance broke and was soldered. The question is, did the wire

break due to its tensile strength being exceeded at the sharp bend or was it due to the proximity at that point to the soldered post?

In Fig. 12 the point X on the diagram marks the position of the following photomicrograph.

In Fig. 13 it is noted that at this distance from the break, approximately one inch, the metal is quite sound and uniform. The dark spots are water spots. It is easy to determine the thermal treatment to which this wire has

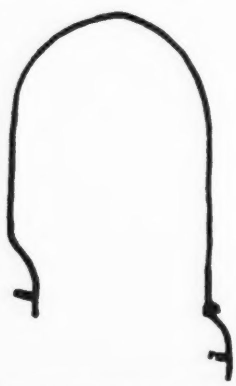


Fig. 11.—Point of greatest breakage and mending in the lingual arch.

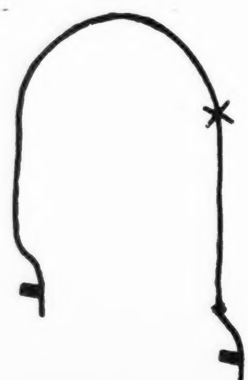


Fig. 12.—Showing position of the first photomicrograph in the broken and mended arch.

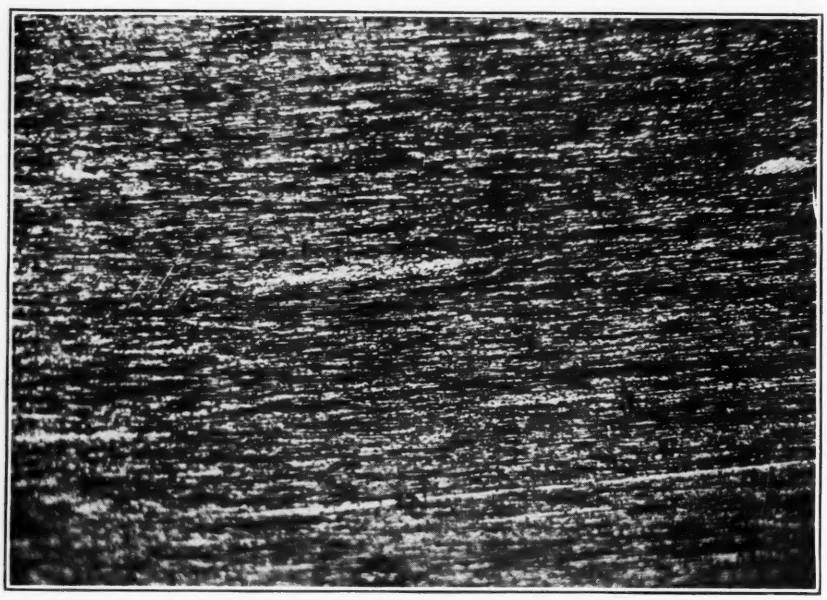


Fig. 13.—First photomicrograph. Most distant view from break. Structure quite uniform. Metal very sound.

been subjected. The continuity in the worked structure is more or less broken up. The wire has been heated to redness and plunged hot.

In Fig. 14 the X in the diagram marks the position of the next photomicrograph. It is considerably closer to the soldered joint.

Fig. 15 shows something strange and new, but not so new as one might believe. The metal which was uniform in the previous photomicrograph, now appears segregated. Segregated metal is never sound. The sharp bend or

point of greatest strain in the lingual arch is still a considerable distance away, yet the wire is beginning to weaken.

In Fig. 16 is seen the position of the next photomicrograph. It is just adjoining the soldered joint.

Fig. 17 shows a number of blowholes in addition to the decided segregation. The blowholes can be noted in and parallel with the area of greatest segregation.

Fig. 14.—Showing position of second photomicrograph.

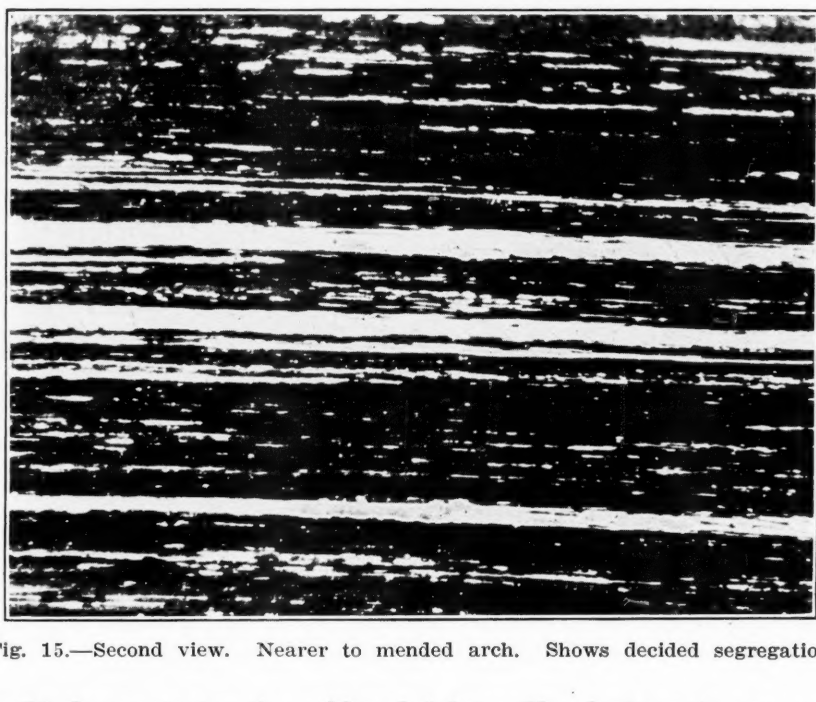


Fig. 15.—Second view. Nearer to mended arch. Shows decided segregation.

Fig. 18 demonstrates the soldered joint. The dark spots are caused by water. The broken wire is on the right side of the photomicrograph. The mottled substance to the left is the solder. The wire is unetched, the solder is etched. This might bring up the question, why is the wire not etched? Why is it not possible to observe the crystalline structure? The reason is quite simple. The rate of etching differs widely in the two metals. The wire is high in gold and platinum. The solder contains considerably more base metals, so of course, is more quickly attacked by an acid.

There can be observed in the wire, the large fissure, crack, or pipe. If this end of the wire contains the pipe, then the other end, which is off to the left and out of the field of the microscope must also contain the pipe. As a point of interest, it can be noted that the solder is also segregated. The field is not uniform. There are also blowholes in the solder. As a joint, it is not a good one. The solder merely touches one side of the pointed end of the wire. Considering especially the long break, there cannot be a great deal of

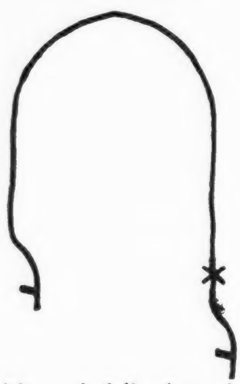


Fig. 16.—Position of following photomicrograph.

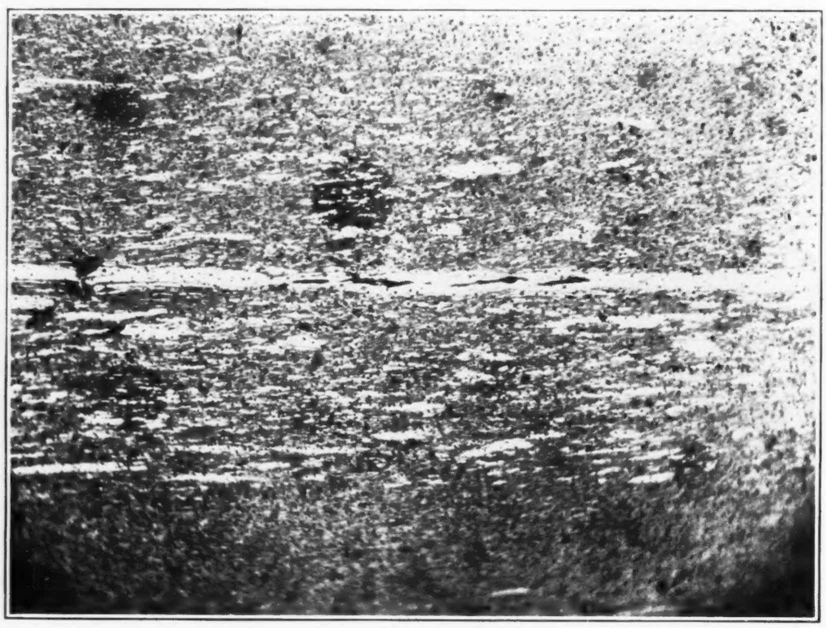


Fig. 17.—View from position immediately adjoining the mended arch. Shows segregation, also blowholes.

mechanical strength in the joint. The juncture of the solder and wire is another point of interest. There is absolutely no penetration of solder into the wire. It is really a brazed joint.

Fig. 19 shows the other end of the joint. In this instance, both the wire and solder are etched. In fact, the solder is over-etched. The wire is now to the left, the solder to the right. The wire, of course, still shows the bad segregation and fissure or pipe; the solder, segregation and blowholes. The solder is still attached to but one side of the wire.

In Fig. 20 can be seen the entire joint. The magnification is, of course, considerably lower.

To conclude, it has been found that this lingual arch broke because the

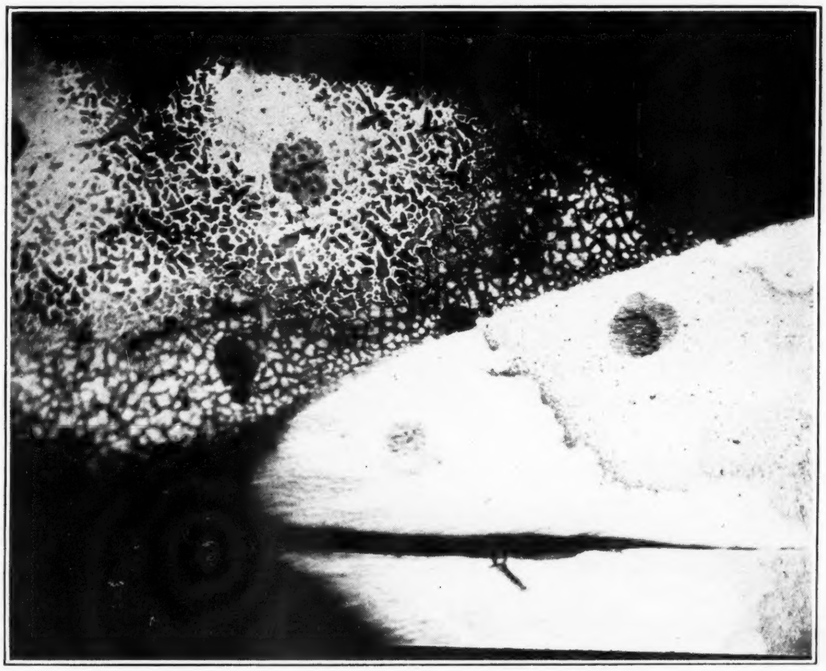


Fig. 18.—Soldered joint. The wire is on the right, the solder on the left.

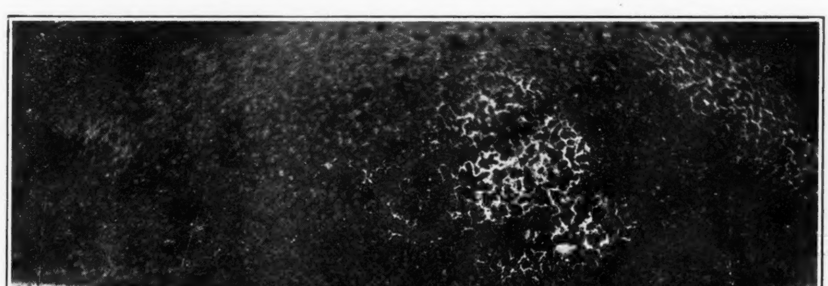


Fig. 19.—Other end of soldered joint. The wire is on the left, the solder on the right.

wire was faulty. It is not believed that the strain at that point, produced by bending, was sufficiently great to injure sound wire. It so happened that the wire was weakest at the point of greatest stress. If this unsound area were

in any other part of the wire, it might never have broken. The wire in this instance contained approximately 20 per cent of platinum. The solder was approximately 650 fine.

SOLDERED JOINTS

(A cooperative investigation in conjunction with Walter H. Ellis, J. Lowe Young, Joseph D. Eby, John V. Mershon.)

Some of the following soldered joints were especially prepared for this examination, others were taken from appliances that had withstood the test of time. It now appears quite fortunate that the work of a number of different gentlemen was examined. False conclusions might have been drawn as to workmanship or even materials. The following illustrations (Figs. 21-29 inclusive) are taken from the work of J. Lowe Young.

Fig. 21 shows a joint soldered by Young. The wires contained approximately 18 per cent platinum. The fusing point of the wire was 1960° F.

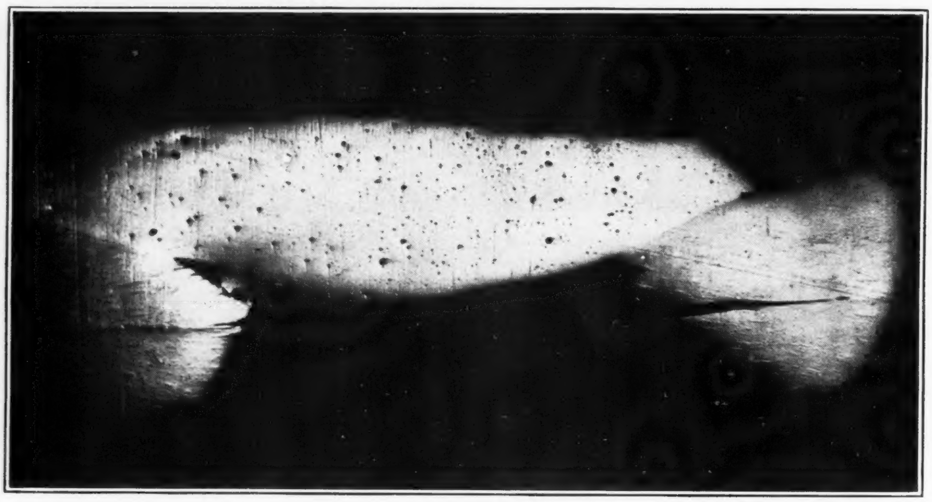


Fig. 20.—Entire joint, showing both ends of wire and the solder.

The solder was 14K 440 fine, fusing point 1360° F. There is a difference in fusing points between wire and solder, of approximately 600° F. The joint is not etched. The solder contains many blowholes and, needless to say, is quite badly segregated. The extremely pitted and darkened areas can be noticed along the margins of both the base and perpendicular wires. It is evident that there was an alloying between the solder and wire to a depth marked by the darkened areas. During the alloying, there were many inclusions of possibly gas, flux or simply oxidized metal. The long lines appearing on the surface are polishing scratches.

In Fig. 22 the wire in this instance contains 17 per cent of platinum, fusing point 1860° F. The solder is 14K, 440 fine. There is one extremely large blowhole and a great number of small ones along the margins of both the base and perpendicular wires.

In Fig. 23 the wire contains 25 per cent platinum and palladium. The fusing point is approximately 2245° F. The solder is 14K. There are the

usual large numbers of blowholes in the solder but there is no penetration of solder into the wire. The right of the photomicrograph shows the joint as a braze, the left as a weld.

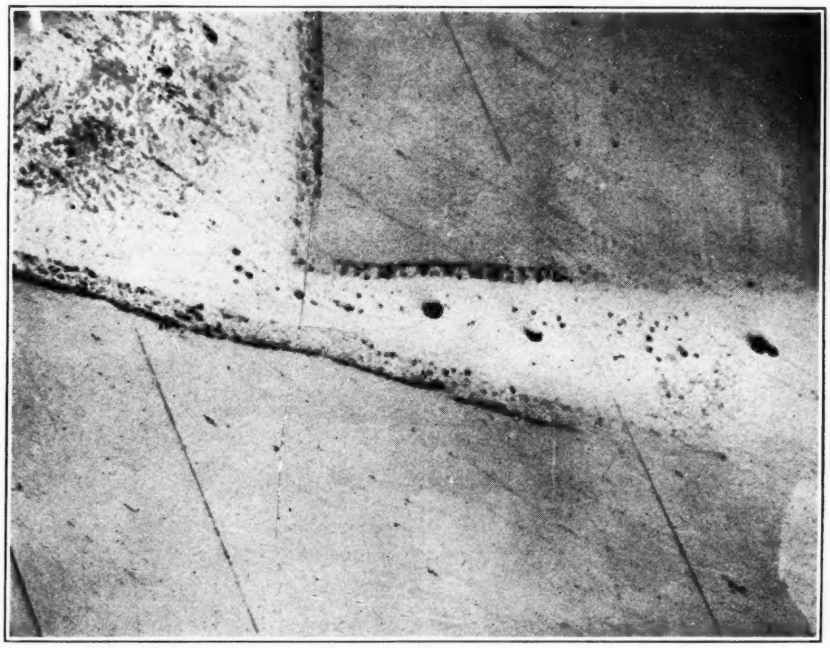


Fig. 21.—Dr. Young 14K joint.

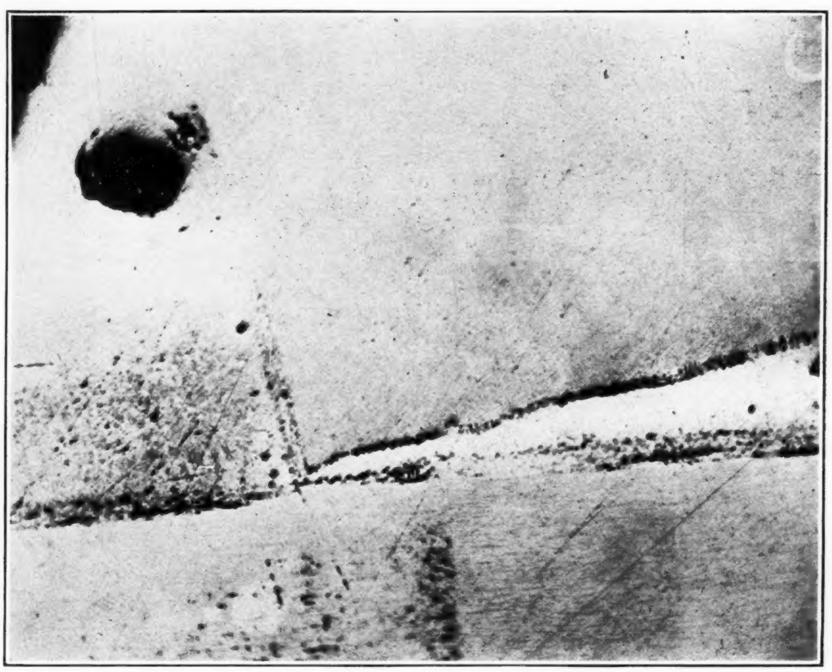


Fig. 22.—Dr. Young 14K joint.

Fig. 24 represents the same joint shown in the preceding illustration. In this instance the wires have been etched. The solder has been over-etched, so the blowholes are not apparent. This illustration again verifies

the nonpenetration of the 14K solder. It also shows that the joint is truly a braze and not a weld. The juncture between base and perpendicular wires

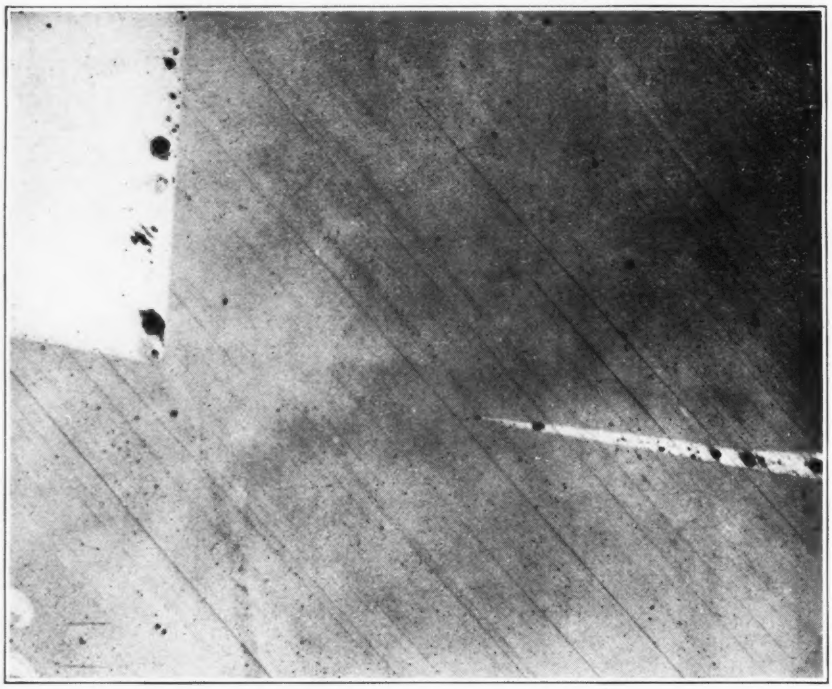


Fig. 23.—Dr. Young 14K joint. Right of union appears as braze. Left as a weld.

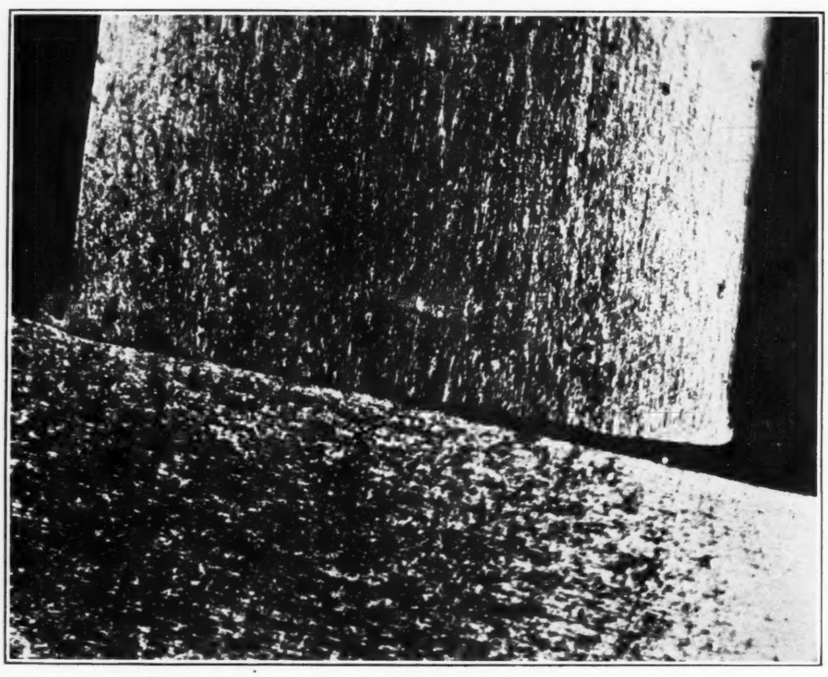


Fig. 24.—Same as preceding illustration only wires are etched. Joint shown as true braze.

is sharply defined. There is no intimate union of the crystalline structure. The wires still show their plainly defined direction of cold working.

In Fig. 25 there are two different alloy wires. This can be observed at

once, due to their difference in speed of etching. The upper wire etched perfectly, the lower wire hardly at all. The solder was 18K, approximately 615 fine. Due to the etching, it is difficult to determine the number of blowholes

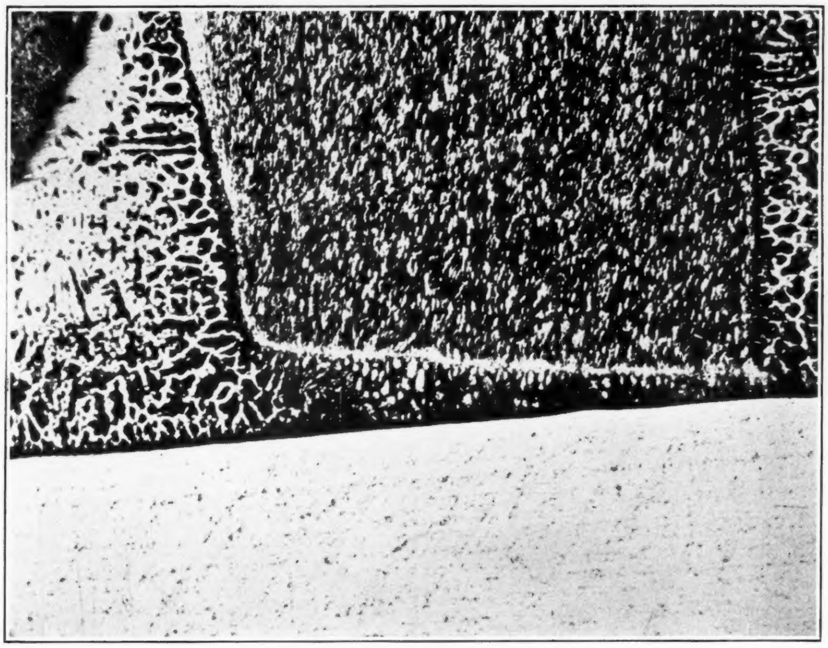


Fig. 25.—Dr. Young. Soldered joint of wires of two different alloys. Shown by difference in etching properties. Shows tapering of upper .020 wire.

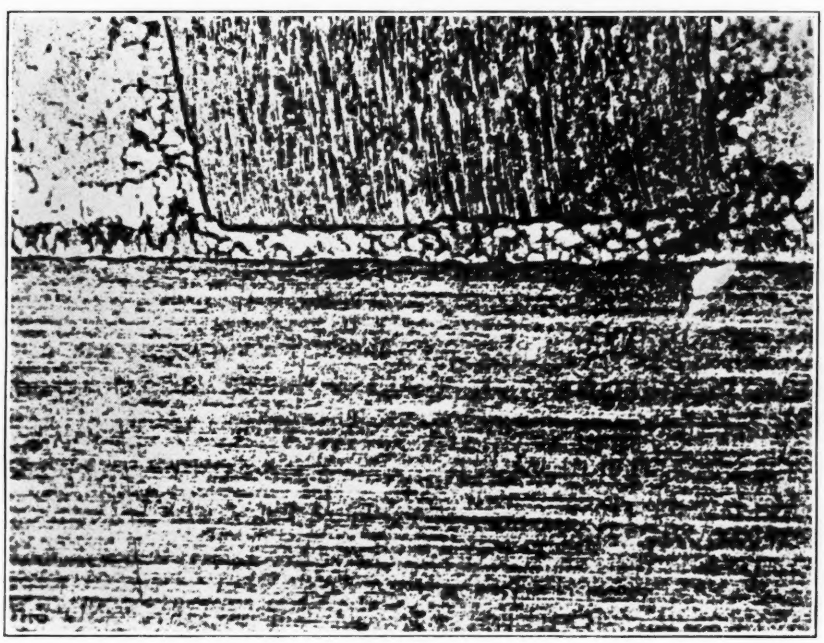


Fig. 26.—Dr. Young. A joint made from wires of the same alloy.

in the solder. One point, however, is of interest and that is the tapering of the upper wire. It alloyed with the solder. There was no alloying in the base wire. Its fusing point was 385° F. higher than the perpendicular wire.

Fig. 26 shows another etched joint, wires of the same alloy. In spite of etching, blowholes are very apparent in the solder. There is again a tapering

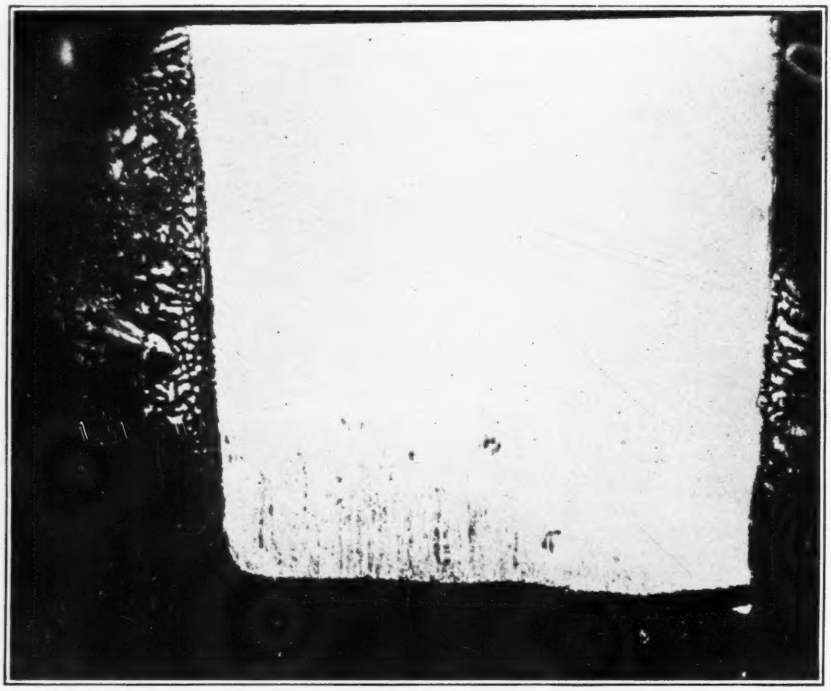


Fig. 27.—Dr. Young. Unetched view of upper .020 wire. Shows fusing or tapering action of 22K solder.

Fig. 28.—Dr. Young. A 22K joint. Quite sound and free from blowholes. Shows slight fusing of upper wire.

of the upper wire. Both wires in this instance are of the highest fusing point or 2245° F. The solder is 18K.

In Fig. 27 unetched wire illustrates the tapering that seems to increase

in direct ratio with the increasing fineness of solder, and decreasing fusing point of the wire.

Fig. 28 shows a joint done with his favorite fineness of solder, 22K. It can be observed that there is a reason for his favoritism. There is not a blowhole in the joint. The small .020 perpendicular wire is slightly tapered.

Fig. 29.—Dr. Young. 22K joint. Sound and free from blowholes. No fusing of the wires.

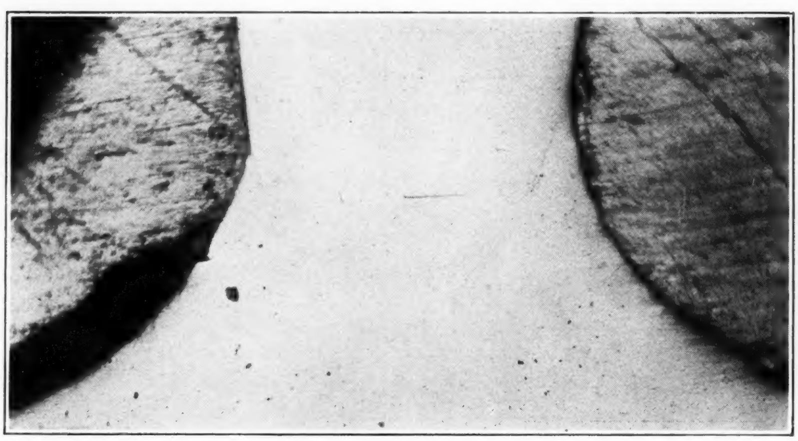


Fig. 30.—Dr. Eby. A 14K joint. Shows blowholes and fusing of wire.

Fig. 29 demonstrates another 22K joint. It is quite sound and there is no fusing of either wires.

To find out whether this superiority in 22K solder is only characteristic of the work of Young, the following specimens, Figs. 30-32 inclusive, were mounted from the work of Eby, who used only 14 and 18K solders.

In Fig. 30 is seen a 14K solder. There are the usual number of blowholes.

The small perpendicular wire is also pointed. This is strange, inasmuch as the wire is extremely high fusing.

Fig. 31 shows an 18K solder. A number of blowholes but more sound than the average.

In Fig. 32 is seen another 18K joint and the poorest of Eby's specimens.

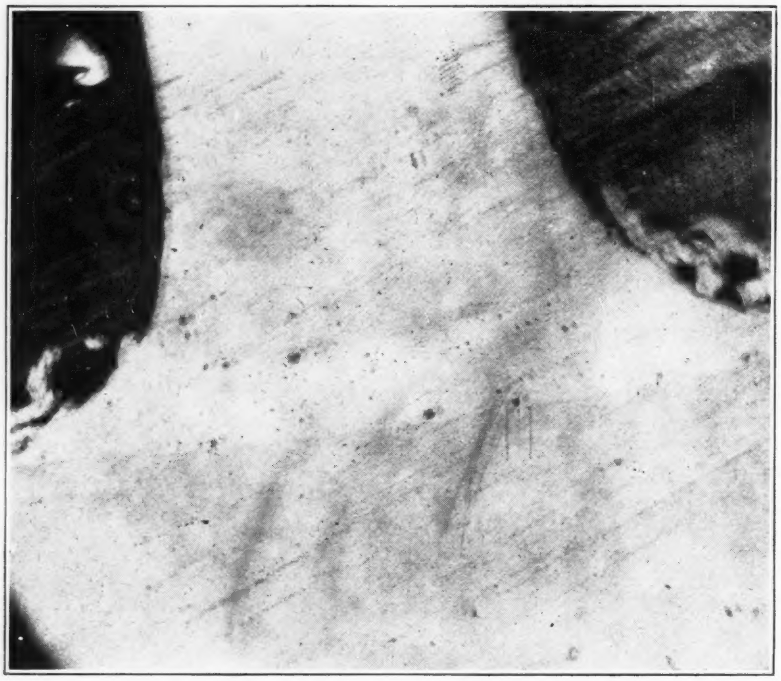


Fig. 31.—Dr. Eby. 18K joint. Shows blowholes. Flaky spots observed outside of joint are particles of gold alloy carried into the lead matrix by buffing.

Fig. 32.—Dr. Eby. 18K joint. Shows great number of blowholes.

The following photomicrographs (Figs. 33-35) were taken from the appliances of Mershon.

Fig. 33 shows the point of attachment of his small .020 auxiliary spring to the top of the lingual arch. It gives another fine opportunity for observing the amount of penetration of the low karat (14K) solder. It can be seen

from the auxiliary spring that in this instance there is none. The same is true of the base wire. There are a great number of blowholes.

Fig. 34 is a view of the small spring that locks over the half-round post. The fineness of solder was not stated. It is a continuous line of blowholes and appears to be 14K.

Fig. 33.—Dr. Mershon. .020 auxiliary spring. 14K solder. Shows great number of blowholes, also nonpenetration of solder.

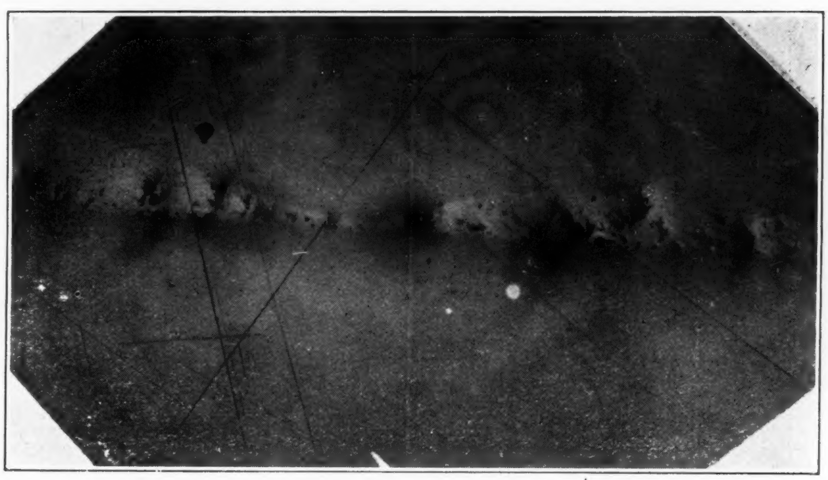


Fig. 34.—Dr. Mershon. Point of attachment of spring lock. Solder contains many blowholes. Straight lines are polishing scratches.

Fig. 35 shows the half-round post. A pedestal effect can be noticed on the base wire. Possibly it was pinched at this point. The solder still shows blowholes, but no penetration into the wire.

All of the preceding slides show that Young accomplished a perfect joint with 22K solder, but there was a tendency to disfigure the wire. The joints constructed by Mershon were full of blowholes but the wire was in no

Fig. 35.—Dr. Mershon. Point of attachment of half-round post to lingual arch. Solder contains some blowholes.

Fig. 36.—Dr. Ellis. 22K solder. Upper wire extremely low fusing. Tapering effect very apparent. Solder does not contain many blowholes.

way injured. Eby struck a middle course. There is still not a great deal upon which to draw any definite conclusions.

The following joints were constructed by Ellis, with wires of various fusing points, and solders of various finenesses. (See Figs. 36-45.)

In Fig. 36 the upper is an .020 14K containing no platinum whatever. The fusing point is barely above the 22K solder used in the joint. The base wire in all of the following slides contains 25 per cent of platinum and palladium. The solder in this instance is quite sound. It can be noticed from the edge of the solder that it was not exposed unnecessarily to the flame in order to smooth down the surface. The upper wire has started to fuse or point. This action must have been noticed. The base wires in all of the following joints have been touched lightly with a file, previous to soldering. This procedure has caused considerable difficulty in trying to arrive at definite conclusions.

In Fig. 37 the upper wire is .020, 16K, contains no platinum, 22K solder.

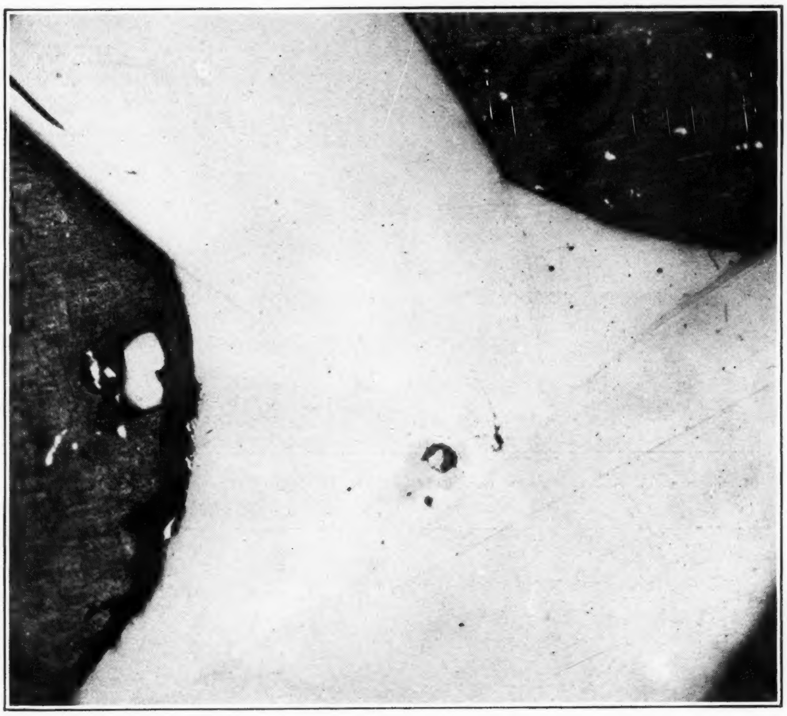


Fig. 37.—Dr. Ellis. 22K solder. Low fusing upper wire. Shows decided tapering, also small blowhole.

There is extreme fusing of the upper wire and the solder contains some blowholes.

Fig. 38 shows a 14K solder; both wires high fusing. It is the first good 14K joint observed.

In Fig. 39 is seen a 16K solder; both wires high fusing. It is the first sound 16K joint observed.

Fig. 40 shows an 8K joint; high fusing wires. A very good joint. Both of these wires have been filed.

In Fig. 4 is seen another 18K joint. In this instance, it is not so sound.

Fig. 42 shows a 20K solder, high fusing wires. In this particular instance the doctor stated that he ''slipped up'' in his technic and he wished to make another joint with these particular materials. The joint is certainly not good.

In Fig. 43 is seen the new joint with the same materials as the previous

slide. It might have looked better from the outside but it is certainly not as good as the "failure."

Fig. 44 shows a 22K solder. There is a surplus of solder on the wire and it is slightly pointed, but the joint is sound.

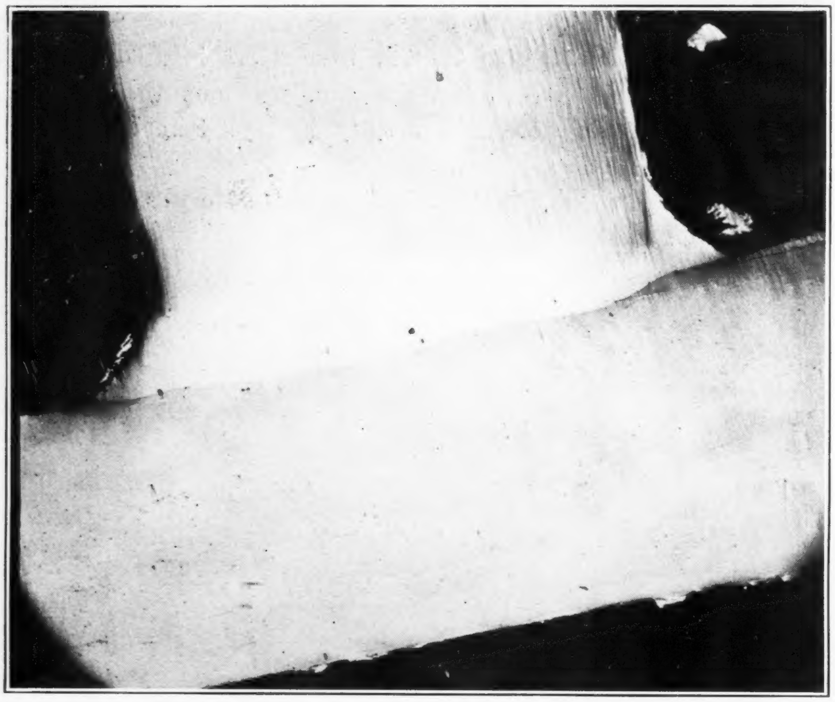


Fig. 38.—Dr. Ellis. 14K solder. High fusing wire. Joint very sound.

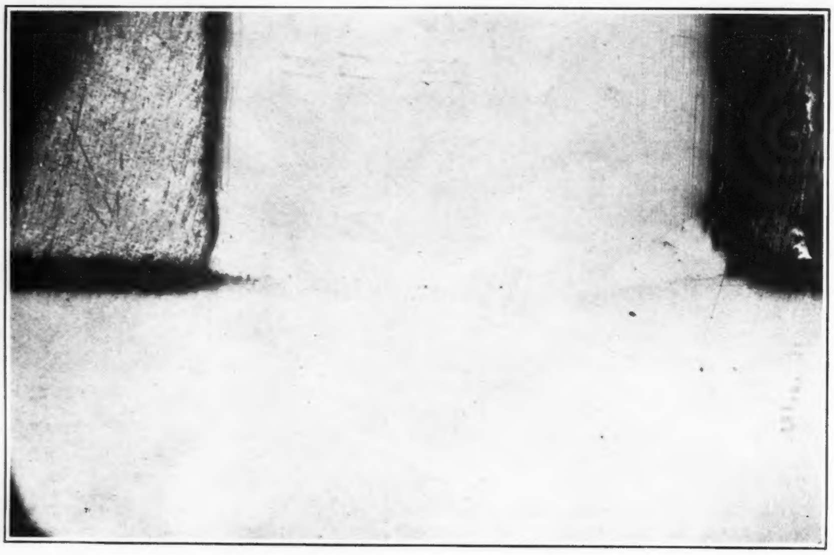


Fig. 39.—Dr. Ellis. 16K joint. No blowholes.

This latter work makes conclusions even more difficult. Good joints were made with both extremes of solders and there was only a slight falling off in the middle. On two particular instances, there is evidence of the work

being removed from the flame very hurriedly, even before the surface was smoothed off. The joints were sound. This would indicate that the best joint is accomplished with the minimum of heat. It has always been the

Fig. 40.—Dr. Ellis. 18K joint. Very sound but shows tapering of upper wire.

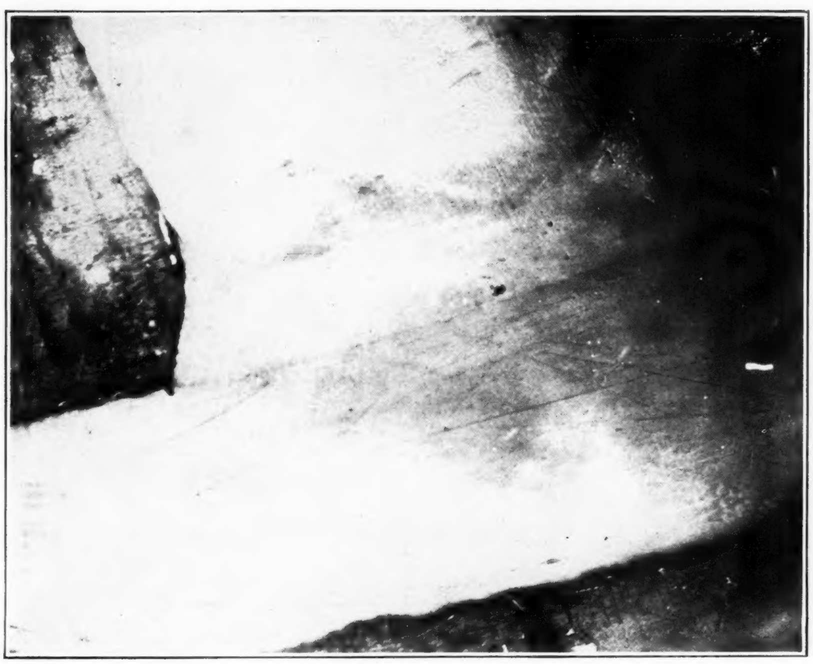


Fig. 41.—Dr. Ellis. 18K solder. Shows a few blowholes.

opinion in the past that low karat solders had a more penetrating and destructive action than the high karat solders. This opinion has probably been formed from watching their action on 22K plate. However, in this instance

metals are being soldered of much higher fusing point. With the exception of the work of Ellis, all 14K joints contained a great number of blowholes. All 22K joints were sound. This would indicate the higher the karat, the better the joint. A metal might contain a great number of blowholes and

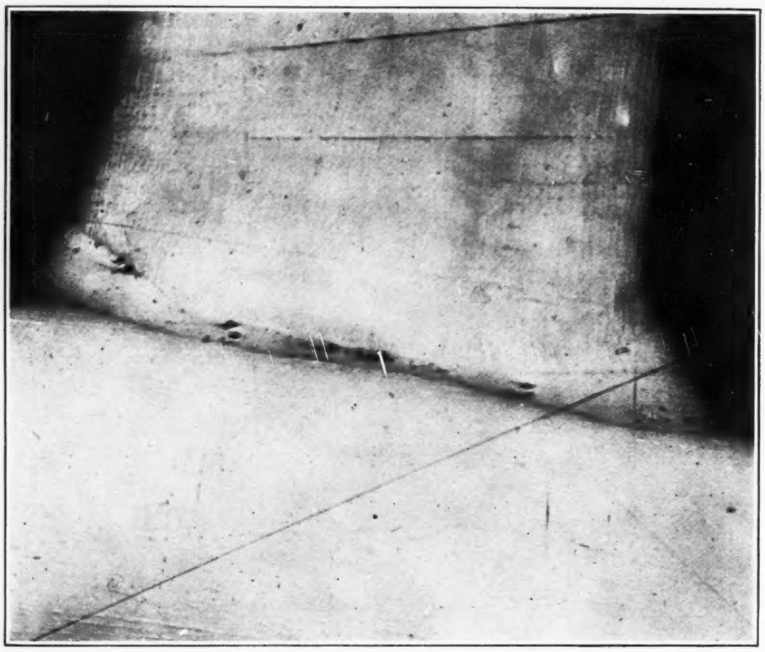


Fig. 42.—Dr. Ellis. A 20K joint. This joint was declared a failure and a new one was soldered. Shows a number of blowholes.

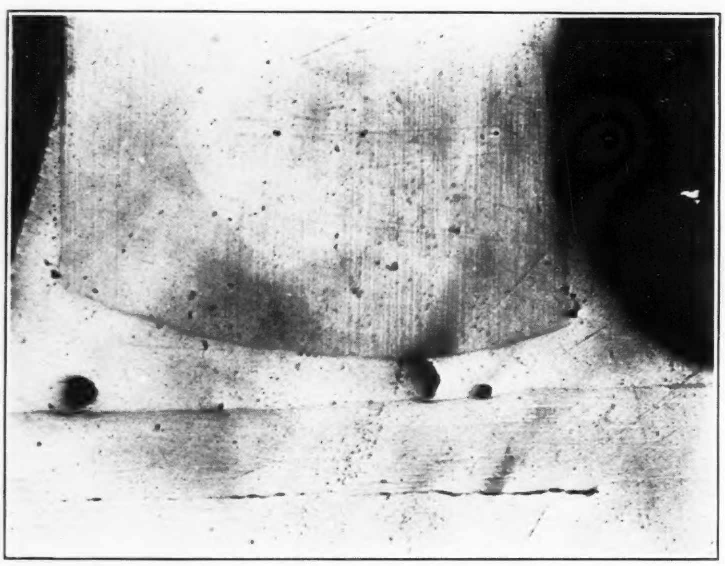


Fig. 43.—Dr. Ellis. This is the newly soldered 20K joint. It is not as sound as the previous attempt.

still be high in tensile strength, but it would most certainly be deficient in ductility.

There is another method for determining a possible superiority and that is by mechanical testing.

Ten pieces of spring wire were soldered end to end. Two each were soldered with 14, 16, 18, 20 and 22K solders. The gauge of the wire was .032. These wires were broken in a tension test with the following result.

None of the wires broke at the soldered joints or near the soldered joints. They did not break in any of the areas touched or discolored by the flame.

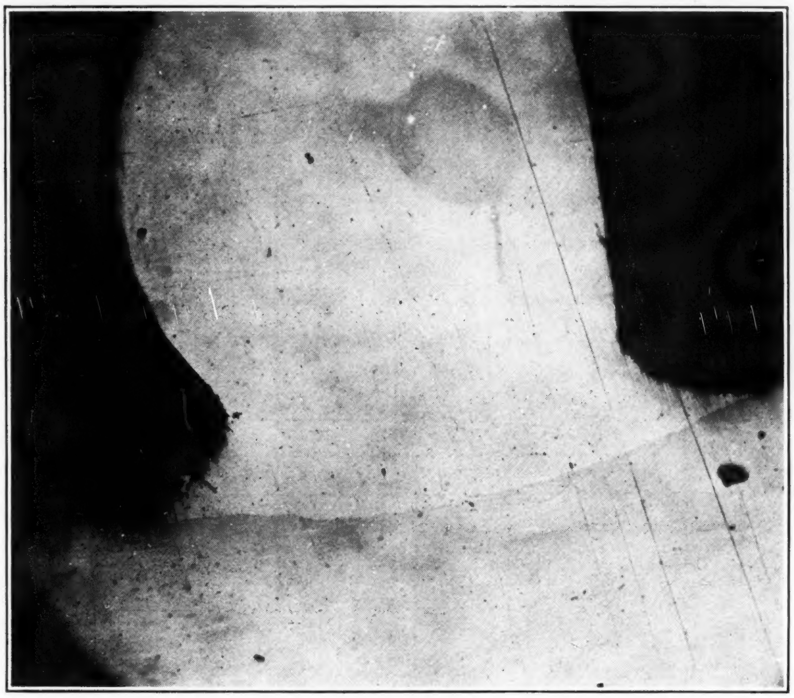


Fig. 44.—Dr. Ellis. A 22K joint. Very sound, no blowholes.

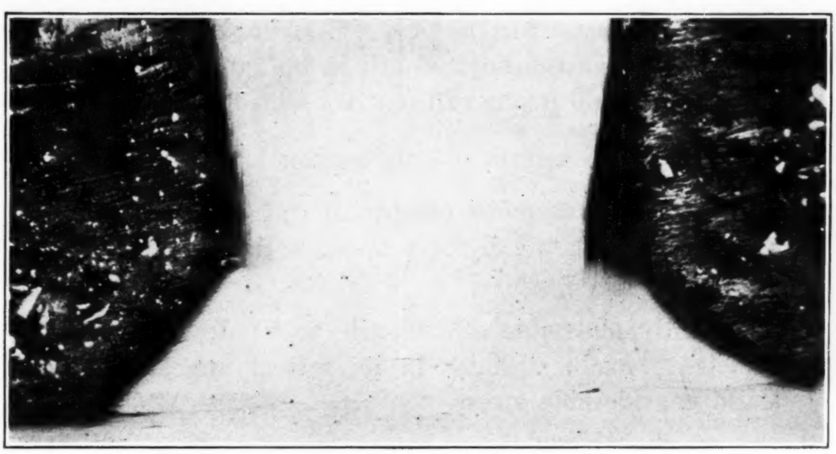


Fig. 45.—Dr. Ellis. Another sound 22K joint.

The joints in all instances possessed greater tensile strength than the wires. No attempt was made to file off overlapping solder. If this were done it was thought that the test would not be practical. These figures of tensile strength in pounds per square inch consequently will not apply to the solders. The information gained is that the wires broke before the soldered joints and incidentally there is shown the very high tensile strength of the wires.

The following mechanical tests were conducted on the different karat solders alone, in order to learn something of their physical properties. It is seen that the higher karat solders possess greater ductility but the lower karats possess a great deal higher tensile strength.

An unsuccessful attempt was made to unite the wires by electrical brazing. There seems to be a great possibility for future research along these lines.

To conclude with the subject of soldered joints, it can only be said that the findings are the result of a very brief research and it seems that the question of solders must still be left to judgment and experience. So much of this operation depends entirely upon the personal factor. It appears that most of the wire breakage occurs near the soldered joints and not at the joints. This would indicate that the extremely high fusing 20 per cent plat-

	SOLDER	TENSILE STRENGTH
1.	14 K.	104,000 LB. PER. SQ. IN.
2.	14 K.	109,000 " " " "
3.	16 K.	112,000 " " " "
4.	16 K.	111,600 " " " "
5.	18 K.	112,600 " " " "
6.	18 K.	112,500 " " " "
7.	20 K.	112,000 " " " "
8.	20 K.	111,600 " " " "
9.	22 K.	112,500 " " " "
10.	22 K.	107,600 " " " "

Fig. 46.—Tensile strength tests of spring wires soldered end to end and broken in dynamometer.

inum iridium alloys are ideal for the purpose. Although the elastic range of this alloy is quite low, the tensile strength in its softest state is quite high. There would certainly be no fusing of the wires with the highest karat solders.

CHEMICAL COMPOSITION

Just a word as to the chemical composition of orthodontic spring alloys. Orthodontia requirements call for a metal with:

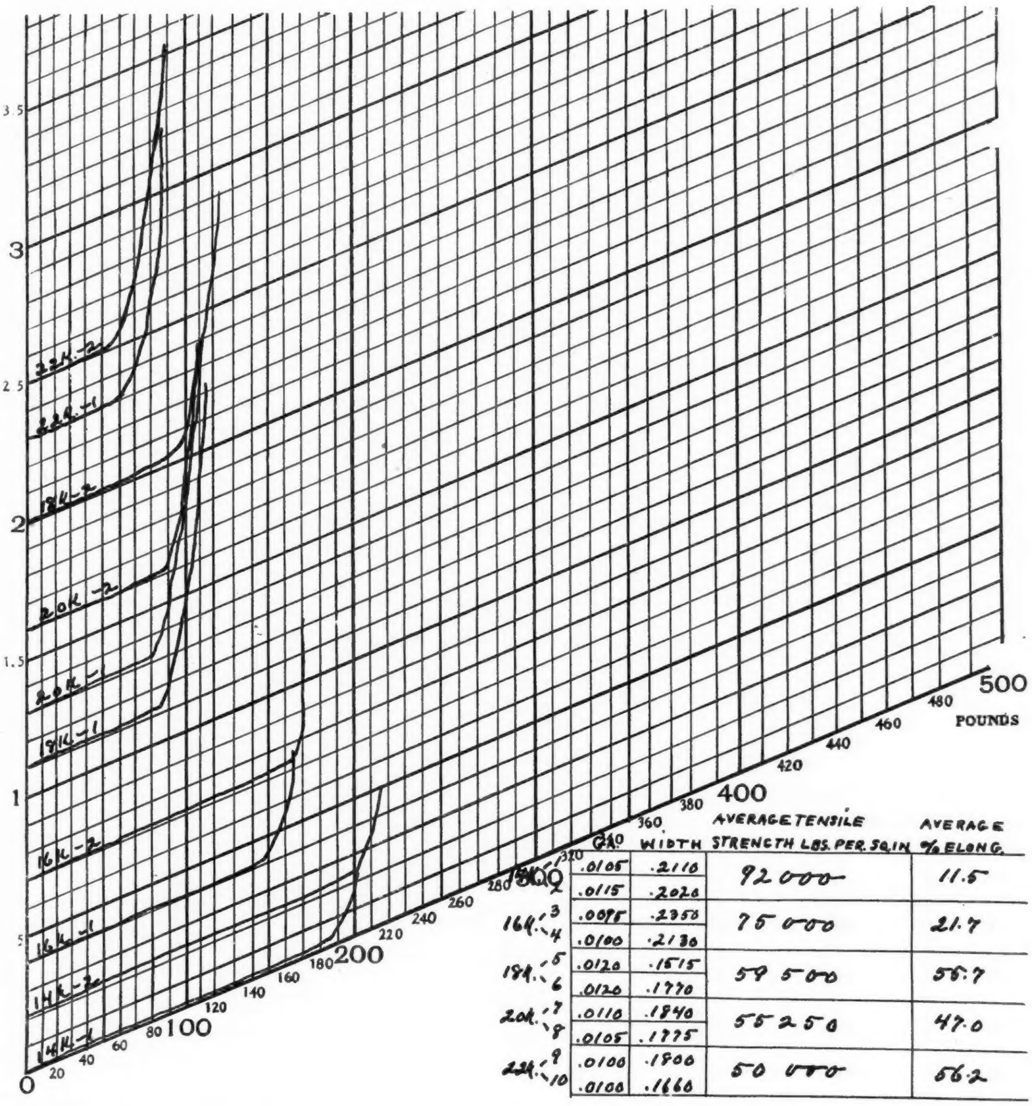
1. High melting point.
2. Sufficiently malleable and ductile to be drawn into wire, yet of sufficient tensile strength in its softest annealed state to withstand considerable stress.
3. Not easily oxidized.

The problem of the dental metallurgist is to give the orthodontist a metal possessing the maximum of these desirable characteristics at not too great a cost. He must be certain that the metals entering into the composition of the alloy which he is using to replace platinum-iridium, form a homogeneous solid solution.

In May, 1917, F. A. Fahrenwald carried out an extensive research in the hope of developing alloys that could replace platinum in the industries. A

brief statement of his findings is as follows: "It is theoretically indicated and has been experimentally proved to the satisfaction of the writer, that no other possible combination of elements can result in alloys of equally enhanced properties, when judged with platinum as a criterion."

The criterion in this instance is platinum-iridium, which makes it even more difficult. It has been noted from the photomicrographs how, even un-



	GA.	WIDTH	AVERAGE TENSILE STRENGTH LBS. PER SQ. IN.	AVERAGE % ELONG.
1	.0105	.2110	92 000	11.5
2	.0115	.2020		
16K. 3	.0095	.2350	75 000	21.7
4	.0100	.2130		
18K. 5	.0120	.1515	59 500	55.7
6	.0120	.1770		
20K. 7	.0110	.1840	55 250	47.0
8	.0105	.1775		
22K. 9	.0100	.1800	50 000	56.2
10	.0100	.1660		

Fig. 47.—Stress-strain diagrams of 14-16-18-20-22 karat solders, showing higher tensile strength but lower ductility of low karat solders.

der most expert manipulation, the metal fused under the action of solder. It is fairly certain that this would not occur in platinum-iridium wires.

Fahrenwald drew further attention to the Werner rearrangement of the periodic table.

The chart in Fig. 49 shows the periodic arrangement of the common elements, starting with hydrogen in the upper left hand corner, with an atomic weight of 1, down to thorium with an atomic weight of 232.5.

Within any one group in this chart, there is no sudden change in properties, when passing from one element to the next in order. Note the group of metals, boxed in on this table. They are rhodium, iridium, palladium, platinum, silver and gold.

Fahrenwald's best solution for a partial replacement of platinum was a combination of gold and palladium. This alloy does not possess sufficient tensile strength for orthodontic purposes. Additional metals must be added or

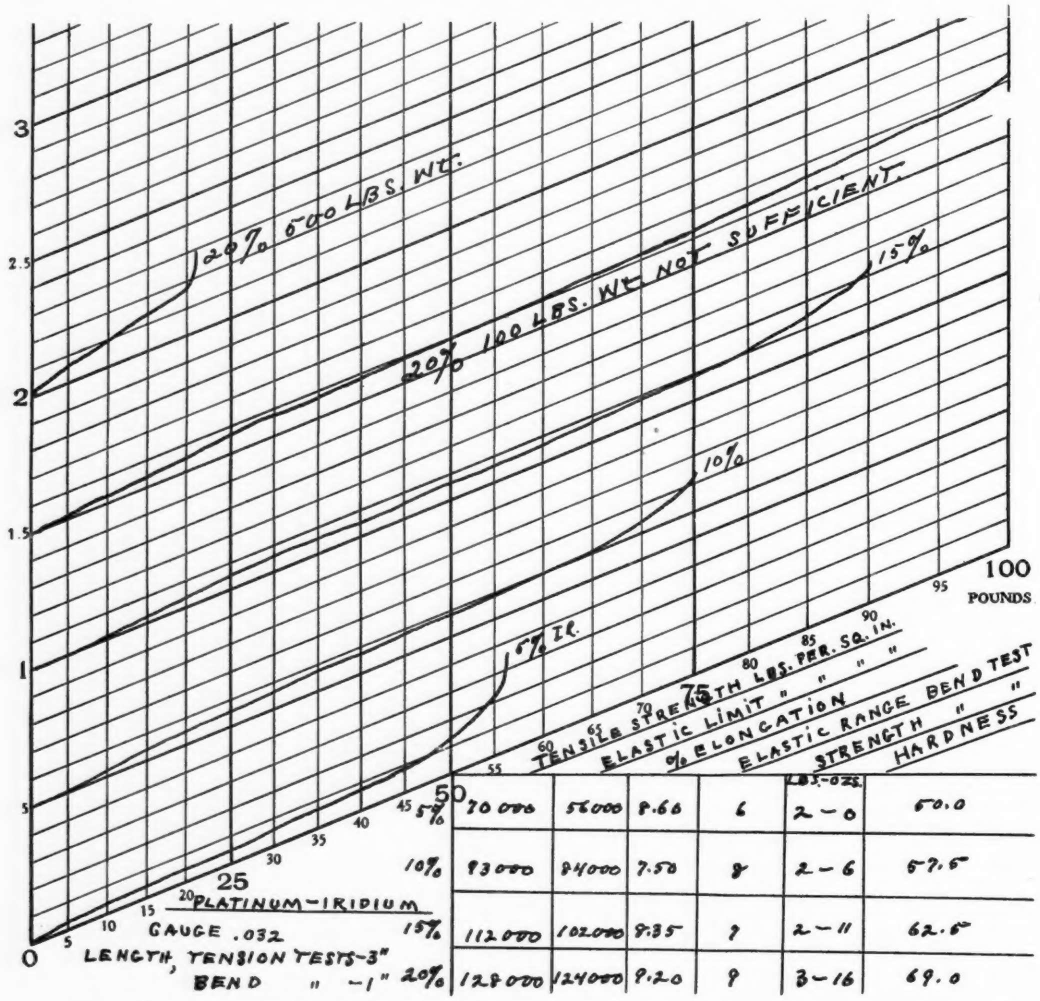


Fig. 48.—Stress-strain diagrams of platinum containing 5-10-15-20 per cent iridium. In addition to tensile strength, elastic limit and percentage elongation, chart also shows elastic range and strength by the bend test, and hardness. (Rockwell.)

a new combination formed. If the primary idea is to reduce expense, iridium and rhodium cannot be used. Platinum, palladium, gold, silver, and sometimes small amounts of metals adjacent to this group may be employed. For instance, small amounts of copper and nickel add considerably to the tensile strength and zinc seems to be beneficial to the original cast ingot, possibly as a scavenger or deoxidizer to clear out the blowholes, oxides, and so on, in a manner very similar to titanium in steel.

Incidentally, Fahrenwald developed a gold coated tungsten wire for orthodontic use. This wire, however, was found to be too brittle for general use.

Before passing on to the mechanical tests and heat-treatment, a few more explanations will be necessary.

Testing is the determination of the properties of a material. It is measured usually by the application of a force and its resultant effect. The force applied is termed "stress," the resulting deformation "strain."

Stresses may be classified under different headings. The steady stress which is invariably used is called "static" stress. Suddenly applied stress is known as "impact" stress. Repeated "impact" stress is known as "dynamic stress." There are also various interesting combinations of these tests, for instance, the "ballistic" test. This test consists of shooting projectiles in rapid succession at steel armour plate. It measures the dynamic hardness by resistance to penetration under violent impact. There are a great many instruments and a great many refinements in the methods of making these tests, but this is a large field in itself.

There is an organization known as the American Society for Testing Materials. There are in the society thirty-nine committees, at least nine of which are working on metals alone.

	1	2	3	4	5	6	7	8			1a	2a	3a	4a	5a	6a	7a	
I	H 1.008 -258?	(ELEMENT) (ATOMIC WEIGHT) (MELTING POINT)																I
II	Li 7.03 186.0	Be 9.1 900 ?	B 11.0 2200?	C 12.0 ?											N 14.04 -210	O 16.0 -235 ?	Fl 19.0 -223	II
III	Na 23.5 97.0	Mg 24.36 651.0	Al 21.1 658.0	Si 28.4 1400											P 31.0 44	S 32.06 (110/114)	Cl 35.45 -102	III
IV	K 39.15 62.0	Ca 40.7 805	Sc 44.1 1400?	Ti 48.1 1850?	X 51.2 1750?	Cr 52.1 1505	Mn 55.0 1225	Fe 55.9 1520	Co 59 1490	Ni 58.7 1450	Cu 63.6 1083	Zn 65.4 419	Ga 70 30	Ge 72.5 900	As 75.0 800?	Se 79.1 217.0	Br 79.96 -7.0	IV
V	Rb 85.4 38.0	Sr 87.6 830	Y 89.0	Zr 90.7 1600	Nb 94.0 2100?	Mo 96.0 2500?	?	Ru 101.7 2000?	Rh 103. 1900?	Pd 106. 1550	Ag 107.93 961	Cd 112.4 321.0	In 114 155	Sn 118.5 232	Sb 120. 630	Te 127.6 451	I 126.5 +114	V
VI	Cs 133.0 28.0	Ba 137.4 850	La 138	Ce 140 645?	Ta 183 2900?	W 184 3200	?	Os 191.0 2700?	Ir 193.0 2300?	Pt 194 1755	Au 197.2 1063	Hg 200.3 -39	Tl 204.1 302	Pb 207.1 327.0	Bi 208 270			VI
VII		Ra 225 ?		Th 232.5 1700?														VII

PERIODIC ARRANGEMENT OF COMMON ELEMENTS

Fig. 49.—Showing grouping of similar elements in periodic table.

Fig. 50 is a "stress-strain" diagram. It is recorded automatically on the instrument that will be shown later. The graphic diagram from left to right, records the pounds required to break the material. From bottom to top is the record of the stretch before the material broke. For these tests elastic limit has been termed as "that point on the elastic curve beyond which the ratio of stress to strain ceased to be constant." That particular point is quite apparent on this curve. Knowing the elastic limit and breaking point of the sample, in pounds, the necessary mathematical calculations are made to find these values for a square inch. Knowing the original length of the metal and diameter, percentage of elongation, and reduction of area are easily calculated. These longitudinal strain tests give considerable valuable information. However, in orthodontic work there is not a great deal of longitudinal strain.

Fig. 51 is a diagrammatical representation of what actually takes place in the everyday bending of wires; also a representation of what occurs in two of the testing instruments. A stress is applied upon the area A B C D. When the bend has been accomplished, former area A B C D has been transformed into area A′ B′ C′ D′. The area A′ B′ X′, X being the center of the

wire, has been subjected to severe compression. The area C′ D′ X′ has been subjected to severe extension. The amount of compression or extension in the two areas is directly proportional to its distance from X or the center. The strains are most severe on the two outer surfaces. For this reason, it can be seen that wires of small cross section can be subjected to much greater strain without rupture than the identical alloy in a larger gauge. For this reason it is concluded that in order to obtain maximum efficiency with the minimum danger of breakage the orthodontist should have wires of varying

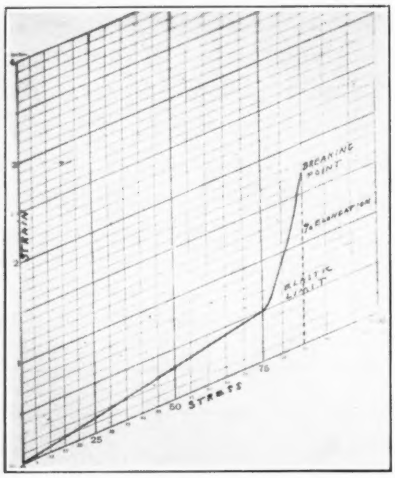


Fig. 50.—Graphic stress-strain diagram, showing elastic limit, percentage elongation and breaking point.

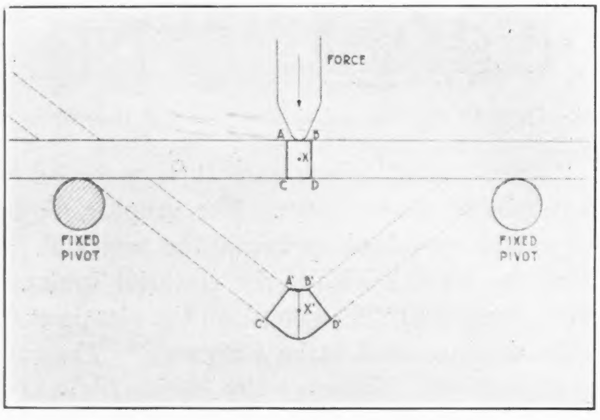


Fig. 51.—Graphic representation of bend across diameter of wire.

degrees of tensile strength—the maximum in the smaller gauges, the minimum in the larger gauges. The zone passing through the center of the wire is known as the "neutral axis." There is practically no strain in the metal at that point. A′ B′ X′ is the "zone of depression." C′ D′ X′ is the "zone of tension." The greatest stress acting to rupture this wire at its point of strain is its own area A′ B′ X′.

In the bend test, the elastic limit of only the extreme outer portion of the wire has been exceeded. That portion most distant from the neutral axis in the area of tension is subjected to the greatest stress and strain.

Fig. 52 is a photograph from Sauveur which shows the crystalline distortion of the metal at the point of the bend. Also the widening of the neutral axis as the distance from the bend increases.

Fig. 53 shows the instrument that was used for determination of elastic range, or as it is called by Pullen, "usable elasticity." It measures the point of permanent set in a bend across the diameter of the wire. It is only a comparative measurement. It is quickly operated and, once values have been established, quite valuable for routine testing.

Fig. 54 shows an instrument which measures comparative bend strengths. Possibly, it more correctly records the stress within the yield point or elastic

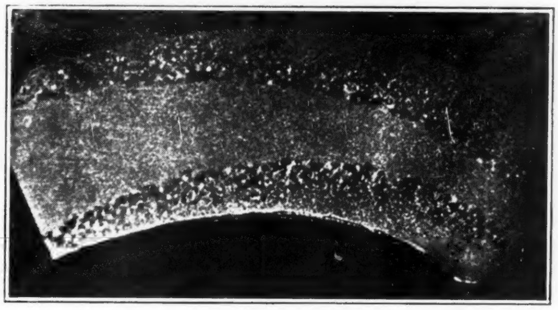


Fig. 52.—Photograph from Sauveur showing crystalline distortion at the point of bend.

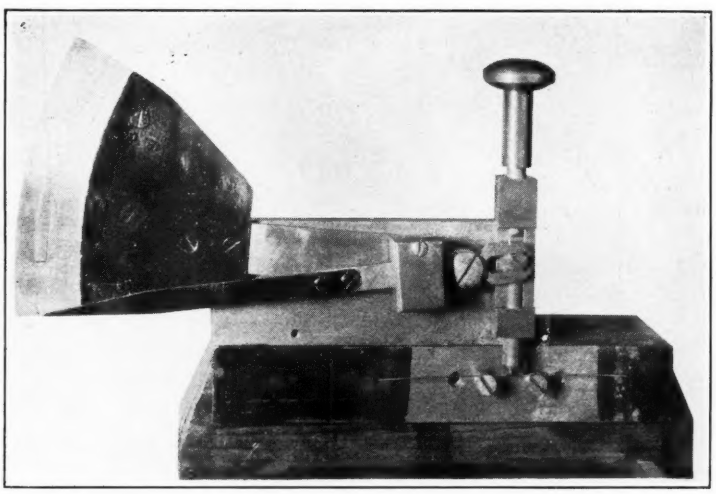


Fig. 53.—Instrument used in the determination of elastic range.

limit; it is also very quickly operated, and after standards have been established is extremely useful in routine testing.

Figs. 55 and 56 are two illustrations which have been shown several times before. They center around a point about which there has been considerable confusion. They deal with the heat treatment and hardening of wires.

Fig. 55 is a photomicrograph of a spring wire magnified 1000 diameters. It has been annealed and plunged hot. It is a longitudinal view. Considering the extremely high magnification the alloy is very uniform. The evenly mottled appearance of the background is noted. In this state of heat-treat-

ment there is no perceptible intermetallic compound. This metal has a tensile strength of approximately 105,000 pounds per square inch.

Fig. 56 shows the same view and magnification of the same wire after being heat-treated or hardened. It has an increased tensile strength of over 20,000 pounds per square inch. In this instance the background has coalesced into rounded crystalline groups surrounded by a dark or almost black appearing material. This dark material is the intermetallic compound. According to theory this compound forms a hardened matrix around the crystalline groups and tends to prevent slipping.

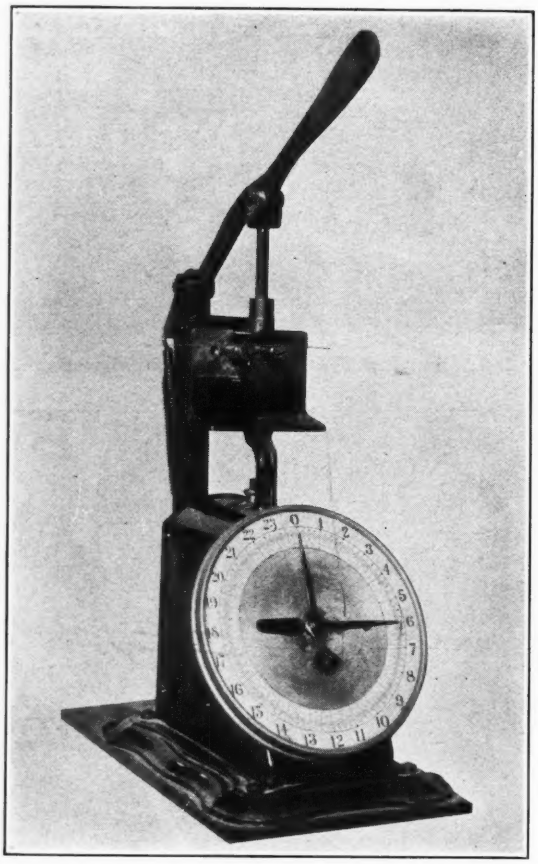


Fig. 54.—Instrument used for determination of bend strength.

Previous heat-treatment research was conducted on this particular alloy. Due to its own peculiar composition it was extremely sensitive to heat treatment. It would form intermetallic compounds or harden at extremely low temperatures as low as 350° F. It was thought at once that all gold-platinum complex alloys would respond to a somewhat similar treatment but was found that such was not the case. It seems that five minutes exposure at about 600° to 700° F. is a better heat for the great majority of alloys. To obtain maximum hardness, the temperature for proper heat treatment should be worked out for every alloy. The charts that were previously prepared, only apply to the alloy on which research was conducted at the time. Some of these complex alloys do not seem to respond at all to heat treatment. If an

alloy does not harden by heating to redness and air-cooling there does not seem to be any use in trying to gain additional hardness by heat-treatment.

"Tempering" is the relieving of a strained condition. It is a softening, not a hardening action. In steel, tempering consists in annealing a quenched or hardened material at a temperature below its transformation temperature. The transformation temperature in complex gold-platinum alloys is the temperature at which the intermetallic compounds appear. Below this temperature, there is no hardening of the metal. In dentistry, what is termed "tempering" is really not tempering but hardening.

At this time it might be well to mention various points that have been brought out by Pullen—whether in defining terms of heat-treatment should

Fig. 55.—Spring wire that has been heated to redness and plunged hot into dilute acid.

the definitions as laid down for iron and steel be adopted even though the resultant effects are opposite. Tempering is a softening, modifying effect; it means bringing about a certain condition of hardness, but accomplishing this hardness by modifying an even more hardened condition. Taking tempering in its true sense, there seems to be little application for this word in orthodontia. The word "harden" could better take its place.

The operation of annealing consists in taking a metal to a high temperature and allowing it to cool very slowly. The object of annealing has always been to make the metal softer, more homogeneous, and workable. The annealing of some orthodontia metals that have transformation points below their melting temperatures would cause hardness. This brings about more confusion. Possibly the word "annealing" could be used when anneal-

ing is really meant, and when the metal is plunged into acid while hot, the word "soften" could be substituted.

The orthodontia metallurgic requirements are exceedingly unique. In very few instances can cold working hardness be used. The metals must not oxidize and should possess a high fusing point and tensile strength under conditions that would render most alloys useless.

Most of the research heretofore conducted with precious metals has been with binary alloys and there has not been a great deal written on the subject.

In trying to determine what combinations of metals are susceptible to hardening or heat-treatment the following preliminary physical tests were made. At the present time more accurate and detailed tests are being conducted.

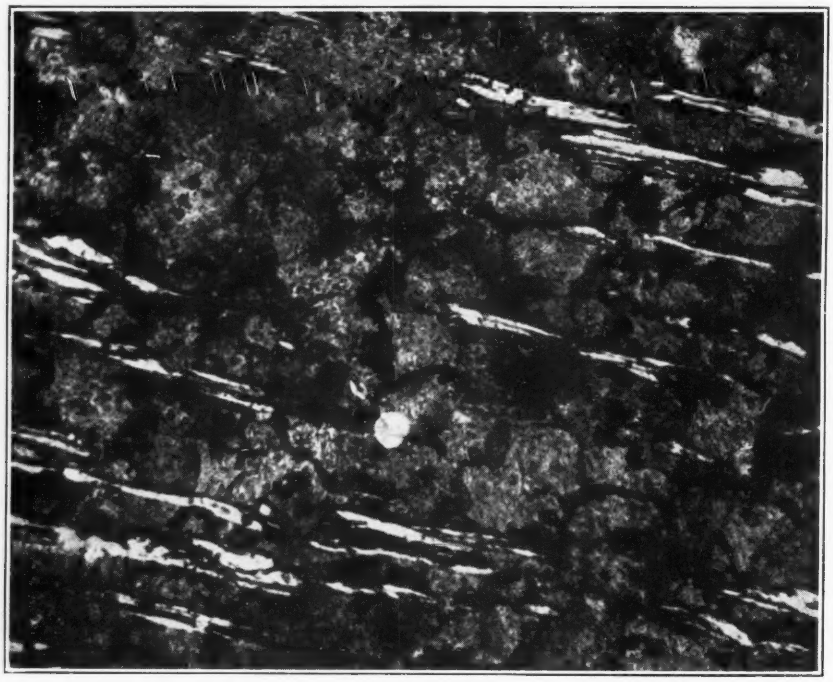


Fig. 56.—Same metal as shown in preceding illustration after being heat treated or hardened.

Fig. 57 shows how these tests were conducted on metals of various formulae. No two cross sections were identical. Consequently the tests on metals even of the same alloy, would not coincide exactly. This applies especially to elongation tests. The figures on tensile strength under the column headed "plunged," represent tests on metal that had been heated to 1400° F. and plunged immediately into cold water. There was no time factor during heating. The heat-treating was carried out in an ordinary commercial dental oven at a temperature of approximately 700° F. The time of exposure was ten minutes and there was no method employed to correct temperature variations in the oven due to continually opening and closing the door. It was desired to approximate the conditions of routine orthodontia practice.

It is observed that in the majority of instances, there was a hardening or increase in tensile strength, varying from almost nothing up to thirty-five per

cent. It is interesting to note that the elongation or ductility decreased in almost every instance.

This chart again illustrates the great many confusing variables entering into the subject of heat-treatment. In order to obtain appreciable and uniform increases in tensile strength, the alloys must be of a formula subject to hardening, they must be absolutely homogeneous and the time and temperature control must be determined accurately.

A great deal of research work will be required to gain a thorough knowledge of these complex alloys.

According to Professor Soldau of Petrograd, the best method of determining the transformation points of any alloy at temperatures below their

GOLD	SILVER	COPPER	PLATINUM	PALLADIUM	IRIDIUM	ZINC	NICKLE	PLUNGED TENSILE STRENGTH	% ELONGATION	HEAT TREATED TENSILE STRENGTH	% ELONGATION	% DIFFERENCE TENSILE STRENGTH	% DIFFERENCE ELONGATION	
90		10						54,000	33.	54,000	30.	0	-9.	
90		10						54,000	35.	56,000	30.	+1.85	-14.3	
90		10						51,400	36.5	51,400	32.	0	-12.5	
90		10						51,400	34.	53,500	36.	+4.1	+5.9	
90			10					28,700	36.5	32,500	41.	+14.	+12.3	
90			10					30,300	36.5	28,500	32.	+6.	-12.3	
90			10					25,000	36.0	27,000	30.	+8.	-16.6	
66	11	6	17					42,700	26.	49,300	31.5	+15.5	+21.	
66	11	6	17					45,000	27.	46,500	31.5	+3.4	+16.7	
66	11	6	17					50,800	30.	54,300	23.	+6.9	-23.	
66	11	6	17					50,800	30.	52,700	24.	+3.7	-20.	
62	15	6	17					89,500	41.5	99300	31.5	+10.7	-24.	WIRE.032
62	15	6	17					83,300	28.5	88,000	19.	+5.6	-31.5	
62	15	6	17					82,500	31.5	92,000	17.	+11.5	-46.	
67	16	12	5					63,000	41.5	83,300	21.	+32.	-49.5	
67	16	12	5					71,500	37.5	78,800	27.5	+9.3	-26.7	
67	1	6	17	9				93,000	38.	113,000	17.5	+21.5	-53	
67	1	6	17	9				80,000	30.	108,000	20.	+35.	-33.3	
67	1	6	17	9				83,000	30.	117,000	24.	+41.	-20.	
55	15	10	18				2	94,000	28.5	116,500	16.	+24.	-44.	
55	15	10	18				2	97,000	35.5	116,500	18.5	+20.7	-48.	

Fig. 57.—Heat-treatment tests conducted on metal of varied cross-section and formulæ.

melting point is by plotting the electrical resistance curves. When any transformation takes place, there will be a break in these curves similar to the break in the ordinarily conducted cooling curves. By conducting a research on alloys of gold and zinc of certain composition he found on cooling a definite compound at 420° C., and a further modification at 270° C. A great deal of time and painstaking care will be necessary to compile this data for all of the gold-platinum complex alloys used in density.

Fig. 58 is an illustration from Soldau which shows the principle of obtaining information as to the compound formations at temperatures below the melting point. From right to left is plotted as time. From bottom to top as temperature.

There is no question whatever as to the increased tensile strength obtained by heat-treating alloys that will form compounds at temperatures below their melting point. There is a question, however, as to whether or not the majority of these complex gold-platinum alloys lost strength after air-cooling by boiling in acid. Experiments of the year before last showed that heat-treated or hardened wire lost no strength, but did lose about 7 per cent of its effective range of elasticity. This year a different alloy was subjected to a series of similar tests.

In Fig. 59 is seen a chart which shows tests conducted on twelve lengths

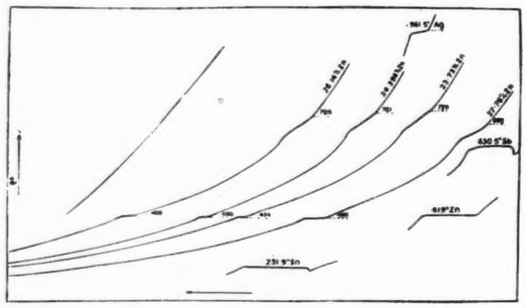


Fig. 58.—Cooling curves by Soldau demonstrating the transformations detected by electrical conductivity.

GAGE .032

		ELASTIC RANGE	STRENGTH	
1.		17.5	2 LB.	8 OZ.
2.	AIR	17.5	2 "	10 "
3.	COOLED	17.5	2 "	10 "
4.		17.5	2 "	9 "
5.		17.5	2 "	9 "
6.		18.0	2 "	7 "
7.	BOILED	17.5	2 "	9 "
8.	20%	19.0	2 "	6 "
9.	H_2SO_4	18.0	2 "	10 "
10.		19.5	2 "	5 "
11.		19.5	2 "	6 "
12.		18.5	2 "	10 "

Fig. 59.—Elastic range and bend strength tests conducted on spring wires that had been heated to redness and allowed to cool in the air. Also wires subjected to this same treatment and boiled in dilute acid.

of a wire all cut from the same coil and subjected to a heat-treatment of 1400° F. for two minutes.

The first six lengths were tested as they came from the furnace. It is noted that they all test fairly uniformly. The average elastic range is about 17.6, bend strength about two pounds nine ounces.

The next six lengths were boiled for twenty minutes in a 20 per cent solution of sulphuric acid. The elastic range, instead of decreasing, increased to approximately 18.7. The bend strength showed an average loss of approximately 1 ounce. This was a direct contradiction to previous findings, so it was decided to conduct additional tests. It is noted from this chart that when there was an increase in the elastic range there was a decrease in the bend strength test.

In Fig. 60 the chart shows a graphic diagram of the tensile strength, elastic limit, and percentage elongation of the same previously tested spring-wire alloy. The first two trials were on air-cooled wires and the second two on wires that had been boiled in sulphuric acid. It can be noted in this tension test that there is not a great deal of distinction between the curves. There is no decided superiority in the air-cooled wires that have not been boiled in acid. All of which shows that a uniform procedure cannot be laid down for all classes of spring wires. The only agreement in all cases is that they should not be plunged hot if there is desired a maximum of tensile

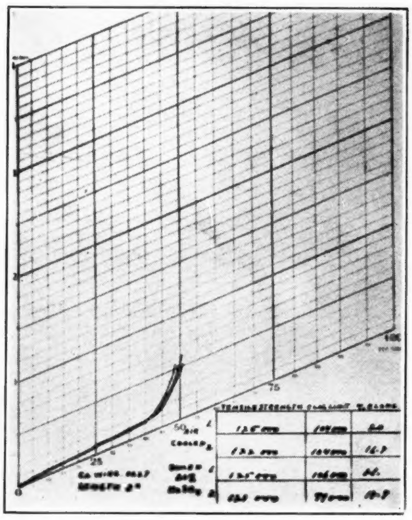


Fig. 60.—Tension tests on spring wires that had been subjected to treatment described in the preceding illustration.

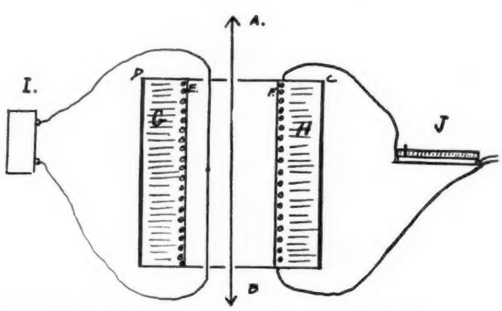


Fig. 61.—Small resistance furnace placed between jaws of dynamometer for determination of tension tests at red heat.

strength and if the metal is not to be subjected later to hardening or heat treatment.

Just a word or two about hot bending. A piece of experimental wire was sent to Young for a few practical tests. He said in regard to it: "The wire is great when bent cold, but when soldered to or bent hot, it is probably the worst I have ever seen."

That meant that data must be gathered on these wires at red heat temperatures.

In Fig. 61 is a slide which illustrates the method employed. Needless

to say, the drop in tensile strength of all these wires at red heat is enormous. The data in this instance has not been completely compiled.

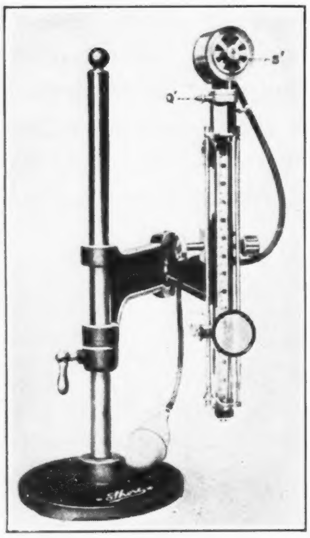


Fig. 62.—Scleroscope. Instrument used for testing hardness of metals. This instrument has been used by the Bureau of Standards for determining homogeneity of metals of the platinum group.

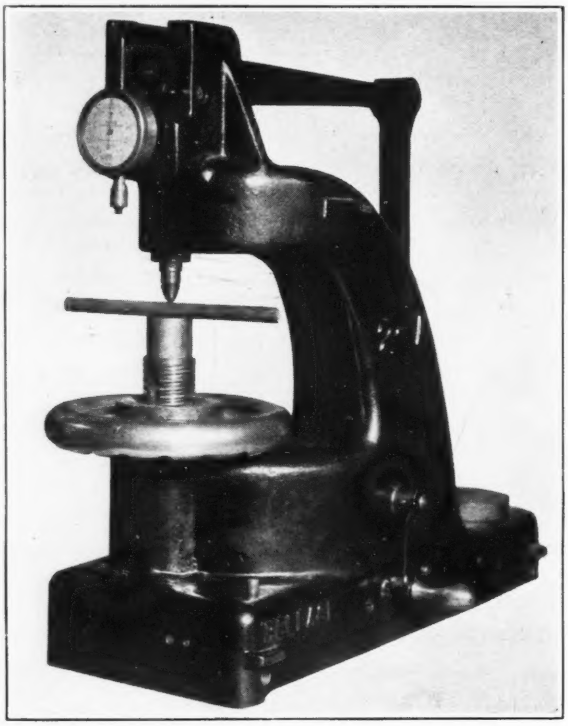


Fig. 63.—One of the instruments used for hardness determinations. Special weights were used and anvils constructed by the manufacturer for determination of comparative hardness of wires as small as .032 in diameter.

The principle of this apparatus is as follows: A B is the wire to be tested for tensile strength at red heat or 1500° F. E F is a small thin walled alundum crucible. Around this crucible are a number of winds of platinum

wire. Immediately around the wire, is a highly refractory alundum cement. The space G H is filled with a heat insulating material such as magnesia. Around this unit is placed a metal cover or pipe, D C. To both ends of this small furnace, are cemented thin alundum discs. These discs are drilled so as to allow entrance of the wire to be tested also to allow entrance into the heating chamber, of the platinum, platinum-rhodium thermocouple wires which

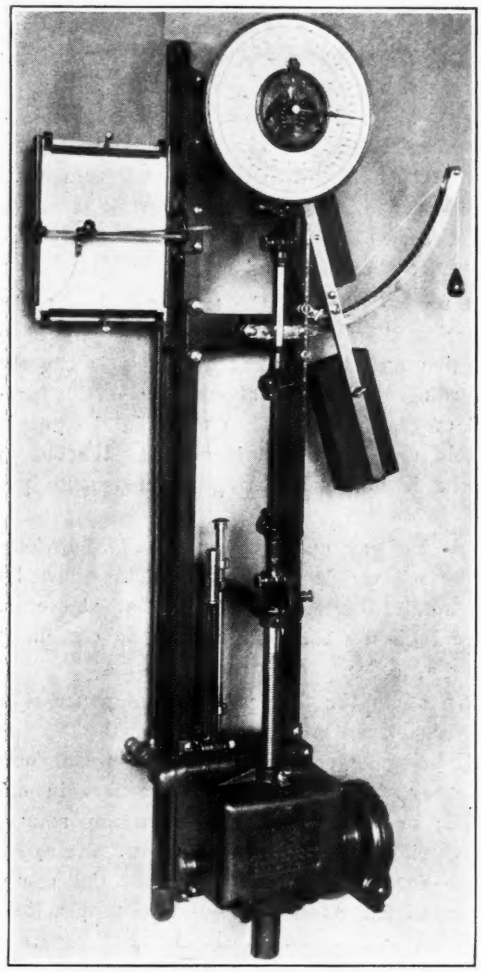


Fig. 64.—Dynamometer with special modifications for testing alloys of precious metals.

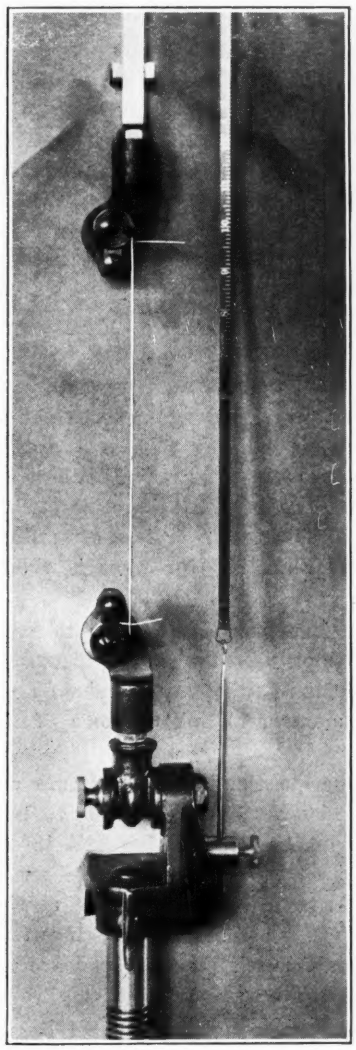


Fig. 65.—Dynamometer grips used to prevent shearing of the metal in the jaws. Three inch lengths of metal were used in most of the tests.

are shown on the slide running to pyrometer I. Figure J is the rheostat which regulates the heat or power input. This entire furnace only measures four inches and is readily fixed between the jaws of the tensile machine.

The remaining time will be spent on heat-treatment; also on the conducting of mechanical tests on these various instruments.

Author's Note.

The above paper is not intended to be conclusive but merely a history of

a certain amount of investigation, the information gained from which the author hopes to use as a basis for further research with the view of improving the metals used in orthodontia.

DISCUSSION

Dr. Waugh.—When our genial Chairman of the Executive Committee, who is now presiding, called me on the phone and told me that he had invited almost everybody in the Society who would be capable of discussing this paper and had not succeeded in finding anyone (and the program was about ready to go to press) to open the discussion, he put me in the predicament of the sailor who had been out at sea for four or five months and was waiting anxiously to get to shore because he wanted to have a good time and see a show. On reaching port he started out with the intention of finding the theater district and on the way quenched his thirst repeatedly, lost his way and eventually found himself in a well lighted building which he thought was a burlesque show. There, the ''pastor of a flock'' was conducting his Wednesday evening prayer meeting. The pastor reaching his climax said, ''On that last day there will be a separation of the sheep from the goats and who would be a goat?'' There was a pause; the drunken sailor, fearing that there might be an interruption, got up and said, ''I beg your pardon, sir, I don't know what you are putting on, but rather than see the show stopped, I'll be the goat.''

I had the privilege of reading the paper on my way out on the train and last night Williams very generously gave me some of his time to show me the illustrations. We have listened this morning to a very excellent presentation and I feel that Williams is eagerly striving for the truth in a manner which is according to the ethical concepts of his profession. The fact that he comes today to tell us of discoveries he has made in the year's research which more or less contradict what he told us a year ago, is evidence that he is earnestly searching for what is right, and that he is not endeavoring to prove any pet theory.

It is unnecessary for me to say that I am in no way qualified, and shall, therefore, not attempt to enter into a discussion of the research problems involved. This must be left for those who have conducted more or less similar investigations. I shall, however, make an effort to link up some of the findings and discuss their application to our daily work.

The question of nomenclature which is spoken of in the first part of the paper is a most important one. Pullen is to be thanked by the organization for his promise of the manuscript he is preparing and in which he will bring before us the nomenclature commonly used in metallurgy. We must ourselves study this before we can express in explicit terms to one another the qualities of metals; or what is of even more importance, before we can convey to the investigators in research those qualities which we desire in the metals which they are endeavoring to produce for us. Because after all, the result of scientific investigation is only valuable to us in so far as it is applicable to practice.

The essayist has presented the work in quite an elementary manner because of criticism of Professor Chamot, but I also feel that in addressing a meeting of clinicians, a paper of this kind should not be too technical.

Williams' explanation of the technic by which the specimens were prepared for the making of photomicrographs renders their interpretation more comprehensible. I have been much impressed with the limited number of metals available for alloys which are suitable to our needs. There seem to be no substitutes for platinum and iridium; therefore, the gold, platinum, iridium alloys, become still more firmly established as those best suited for our needs because the known cheaper metals do not seem to provide the desired qualities.

I was quite surprised to learn the extent to which a given alloy takes on given characteristics. It is shown in the paper and also by the demonstration that general rules cannot apply, but the metallurgist must determine the exact behavior of a given alloy or a very small group of metals. We must acquaint ourselves with these and apply them in

practice if we would obtain the best results, as in heat-treating and as brought out in the boiling test of air-cooled metals in acid solutions which was stated last year would decrease the elasticity seven per cent. During the past year the essayist has found that the degree of change varies with each gold-platinum complex alloy. He is still of the opinion, however, that plunging hot should be avoided as it considerably decreases strength in practically all alloys used in our work.

On the question of tempering, the paper explains that our understanding has not been clear; we have regarded it as a hardening action when it is really a softening, or, in better words, the relieving of a strained condition of the crystalline structure. We agree that more accurate terms for describing the change which we desire in our alloys will be needed. I say this because of his comparison and the seeming contradictions with those terms that are used in speaking of steel.

The possible influence of the fluids of the mouth upon metals used in appliances has been very often discussed and so far as I know this is the first time that a report has been made upon this problem. It is comforting to learn that in the tests made, extending over periods ranging up to nine months, there is no chemic change that appreciably alters the physical properties of the metals. Therefore, all the changes must be brought about by manipulation, either in our work or by the patient.

On the question of the soldered joint, which is such an important one, I have drawn the following conclusions from a study of the paper:

1. The welded joint is not desirable in the type of strain to which orthodontic wires are subjected, because in fusing or near-fusing a metal, its crystalline structure is changed to that of a cast structure, thereby robbing it of the desired qualities developed only by cold working as in being drawn, etc.

2. That in joining metals with solder the ideal may be more nearly approached by using a comparatively high carat solder, for example 22K, as few blow-holes develop, and because the higher carat solder is more ductile.

3. That lower carat solder, for example 14K, develops more blow-holes and is more brittle than a higher fusing solder.

4. That in no case should solder be of a fusing point so the metals to be joined will begin to fuse in the soldering process.

5. That penetration of solder into the parts to be joined is undesirable and, therefore, the metals should be removed from the flame *immediately* the solder begins to flow. That is quite the reverse from what some of us have thought.

Probably better average results are obtained by using a solder of a fusing point considerably lower than the parts to be joined, say four or five hundred degrees lower.

I think we owe Williams a further debt of gratitude for the exhaustive and unselfish way in which he has gone into these tests.

I feel that it will be well for me perhaps to take just a moment to speak of other research that is being conducted in the metallurgic field, because I know it is agreeable to the essayist. Williams is familiar with it as I am sure are other members present, because a letter has been sent out from the Department of Commerce, Bureau of Standards, Washington, to the effect that investigations are being conducted in dental materials which are under five headings. Among them is one which concerns orthodontists and prosthodontists.

This letter which I shall read is very brief. The subject is "Dental Research." It is from the Department of Commerce:

> "1. The enclosed outline of this Bureau's program of dental research is sent for your information regarding the work being done at this Bureau.
>
> "2. Your cooperation in assisting us to specify the physical data most needed by the dental profession is earnestly requested.
>
> Respectfully yours,
> George K. Burgess,
> Director."

The Research Committee of the American Dental Association, I am informed, was approached some considerable time ago with reference to aiding the Bureau of Standards in this work, and was informed by the Chairman of that Committee at that time that they were not in position to offer aid. However, in the *Journal of the American Dental Association*, March, 1924, (which I have not seen) is a report of the Research Committee in which they express a desire to aid in this work.

I am emphasizing this because I feel as members of our specialty we should in some way bring together those things which we desire the Bureau of Standards to know with reference to the requirements of the materials that we use. I believe as the result of such work as that to which we have listened this morning, and similar work by others, that before long a more or less definite series of formulae for metals will result, which will have as satisfactory an influence upon the alloys which we shall use as did that masterful piece of research by G. V. Black about twenty-five or twenty-eight years ago with reference to the alloying of the metals suitable for the making of dental amalgams. Black's work has stood through all these years. The formula has been practically unchanged. Various manufacturers have endeavored to add a little here and there and perhaps have succeeded in improving them in a minor degree, but the basic formula has stood.

The "Outline of Research" being undertaken by the Bureau of Standards in conjunction with the Weinstein Research Laboratories covers a broad field and is as follows:

I. Pattern Waxes*

II. Investments*

III. Gold Alloys for casting*

IV. Gold Alloys (wrought) for Prosthodontists and Orthodontists.
- (*a*) Chemical composition.
- (*b*) Micrographic studies.
- (*c*) Melting ranges.
- (*d*) Annealing temperatures and ranges.
- (*e*) Solders.
- (*f*) Elastic properties for clasps, arches, springs etc.
  - (1) Deflection under stress. (2) Set. (3) Tensile strength and hardness. (4) Resiliency values.
- (*g*) Life tests (repeat stress) for flexures.
- (*h*) Heat treatment of completed appliances.

V. Impression and Cast Materials*

Section IV is of utmost interest to the orthodontist and it seems to me that as a body we should in every way endeavor to cooperate with the Bureau because the results will mean a very great deal to us. The government is putting forth a great deal of effort in this and we should aid in every way we can so that in the end we shall be provided with definite data as to all the physical properties of the materials best suited for orthodontics.

I feel that the Society owes Mr. Williams a deep debt of gratitude and that we should offer him every encouragement in his work on our behalf.

Walter H. Ellis.—I do not know that I could be termed a discussor of this paper, because I have discovered, from Williams' remarks, that I was one of his "test animals." I only hope by thus sacrificing myself, that I have contributed something to science. Those of us who had the pleasure of working with him, were selected, I presume, because we might be expected to show only average ability. He discovered errors, and also some few perfections that we had developed in handling the materials under discussion. Those errors, of course, as disclosed, point the way ahead and give us all an opportunity to continue, improving our technic; and to him, the opportunity is given of suggesting improved formulae for our alloys.

We have had, as you know, some very valuable essays upon other branches of research —pathology, diagnosis, etc., presented to us at our meeting this year; but as I see

*Subdivisions omitted.

the thing the valuable points obtained there, that are applicable to our work, have to be placed in practice on the foundation of some such research as Williams has given us upon these materials by means of which only can we apply the truths discovered in other lines. We might consider metallurgy as applied to our metals, our technic, our appliances, as the motive power of our basic truths. Our appliances must do our bidding. It is of no particular advantage after all, to have an eloquent speaker point out our objective as that beautiful city on the horizon, unless we have the motive power working in an engine of good performance to carry us on the journey.

Williams' researches are of inestimable value to us as evidenced by the changed technic as used by many of us since hearing him in regard to heat-treatment, soldering and manipulation of our appliances. His accurate testing apparatus, not only proves certain positive facts, but also shows the limitations of our metals. To us this is all looking forward; looking ahead to further research, to further work to so nearly perfect our technic as to eliminating many of these errors, so that we may obtain still better results.

No alloy, appliance or technic is perfect or ever will be. We must remember this and be ever striving. We solve our problems only to visualize another from the new vantage point. Each success is simply a stepping-stone to another.

It takes a real research man, a man who loves it and understands his problems, to carry on a work of this kind. It is so easy to tire, to lose enthusiasm without the appreciation and cooperation of those who will in the end receive the benefit. I only hope by our cooperation and appreciation of his unselfish work that he may be stimulated to continue his research in the orthodontic field.

There is nothing I can add in a technical way, Williams and Waugh have covered the ground so thoroughly, that I will merely express my own deep appreciation and that of the Society to Mr. Williams for his valuable contribution to our science.

Dr. Ketcham.—The point of greatest breakage in our lingual appliances is just in front of the lock. At that point we make a bend toward the gingiva and then a bend forward. The change in arrangement of the metals, or the weakness in the wire, as shown by Williams' slides, would indicate that we weaken the wire at that point by our bending. The patient further weakens the wire by moving the appliance up and down, producing stress. So the thought comes to me that less of a bend, or not as abrupt a bend would be better technic to employ.

In regard to the testing machines, if we can get these machines made up at a reasonable figure and Williams will supervise their manufacture, I am sure a large number of our members would like to have them. I know I would.

Mr. Weinstein.—I came here to listen rather than to speak. I had no opportunity to study the paper and to prepare an adequate reply, so I will make only some general remarks.

Williams has made numerous references to his former paper. The two papers are so intimately connected that I must ask your indulgence and refer to the previous as well as to the present paper.

The trend of this paper is almost a complete reversal of his previous paper. He is much less positive and emphatic and qualifies throughout. In this paper he deals with generalities, which is undoubtedly excellent text for students but rather poor data for busy men intensively engaged in practice, who have neither time nor facilities to verify his findings. Furthermore, in his data he speaks principally of experimental alloys and not alloys which are actually in use.

In speaking of chemical composition in his previous paper he pointed out that this was of little consequence but that physical properties, micrographic observations, etc., were of greater importance. A thorough consideration of chemical composition is important in the study of this problem, and we must have known composition as a basis.

In this paper he mentions iridio-platinum as seemingly ideal, but the drawback is expensive. Iridio-platinum wires do not possess spring value like some complex gold-platinum alloys. They may be stiff and rigid but cannot be softened by heat-treatment to any

appreciable extent to facilitate manipulation and then re-hardened by tempering; furthermore, they are rather difficult to solder. Hence, iridio-platinum alloys are undesirable for reasons other than cost.

Then he speaks of not using iridium as an alloying element in the complex gold-platinum alloys on account of expense. There is an entirely different reason for not using iridium in these alloys and this is the difficulty of alloying iridium with gold, platinum, silver, etc., without segregation.

He points out that small percentages of copper, zinc and nickel are desirable. Well, "small" is a relative term like "several" two or three per cent may mean small but the majority of our orthodontic alloys contain ten or more per cent copper and no less will do. The copper plays an important part in the strength, hardness and heat-treatment responsivity of these alloys so it cannot be lightly dismissed by merely stating "small percentages."

Zinc is a very valuable factor in the re-hardening of alloys, and should be considered more specifically. My recollection of his last paper was that he objected to nickel as an ingredient in these alloys, and now he commends it. His reasons for this would be well worth having. Giving the formulae, as I have done, would help materially in the consideration of these problems.

Williams' complete retraction of his data on heat-treatment temperatures and acid treatment of finished appliances does great credit to his sincerity and his earnestness, but reflects on his judgment in presenting incomplete and erroneous findings to the profession.

The same criticism still continues to apply to nearly all the apparatus Williams employs. I am not going to discuss whether the origin he claims for two pieces of apparatus on this table is correct, that is of little consequence. We all think we do original things and find later that they have been done, ten, twenty or thirty years ago. So that is not important.

Last year he most emphatically stated that this was accurate apparatus, and now he reverses himself and qualifies to the extent of stating it is good for relative tests and can be checked by more accurate apparatus. This is ambiguous.

He now shows the Rockwell testing machine with a screw driver under test instead of .022 wire. The screw-driver test is perfect, this is what the machine is good for, but no testing engines would countenance the use of this apparatus for such small diameters as .022 as the hardness of the anvil rather than of the specimen is measured.

I am sorry to hear him mention the use of the scleroscope because of the three types of hardness testing that we have available, the Brinnell, the Rockwell and the scleroscope, the last named is the least suitable for our purpose. Sealing wax tested in the scleroscope compares almost identically with mild steel. I understand modeling compound is three points higher than pure gold.

The principal value of property of orthodontic wires that should be determined is resistance to deflection and the degree of return to normal; such properties may commonly be termed spring value. The less the permanent set after deflection under a given load, the more resilient the wire, and it will be generally found that the tensile strength is quite consonant although not always parallel.

In the paper I referred to before, I described an apparatus for testing these properties, which has met with the approval of the Bureau of Standards, whereas, the method utilized by Williams for the same purpose has been criticised. He, however, has shown a most commendable tendency to correct himself when in error, and this, gentlemen, overshadows his mistakes, so after all, this Society is fortunate indeed in having a presentation of Williams' efforts.

Chairman Eby.—Williams is always so painstaking and thorough in his work that I become completely absorbed in his earnest manner on such occasions as he conducts us in and out through the mystic maze of the science of metallurgy as it applies to the problem of orthodontia. It was very interesting to study the photomicrographs which he showed of the solder joints prepared by the different members. The joints which I prepared were made just as if in the construction of apparatus, by free-hand soldering. The method con-

sisted of using a flux of vaseline and borax, fusing the solder, some of which was 18K and some 14K, first to the larger or base wire, and then by refusion the second piece or auxiliary wire was attached. Williams referred to the depression observed along the longitudinal line of the larger wire, and I am wondering if this was not caused by the effects of expansion and contraction under the above described method of preparing the joints, as no attempt was made to file the surface of the wires.

The very enlightening work which Williams has presented today is in furtherance of the paper dealing with general fundamental principles, etc., which he read before this Society last year. During the interval between these occasions he has also presented a very amplified clinic before the New York Society of Orthodontists. During the past twenty years many revolutionizing advances have been made in general dental science as well as in orthodontia. This progress has all been the result of preparation, study and hard work on the parts of numerous men. As the result of these efforts the question of supply and demand has created conditions which many people in the form of pseudo-scientists and with much less effort have found to be very profitable to them.

Modern progress in orthodontia has brought out the requirement of numerous materials which have been supplied in an arbitrary manner and orthodontists have had to accept them first and determine their worth later. This situation has been very expensive in money, time and efficiency, and among these has been the utter absence of specifications by which the gold and platinum alloys have been compounded.

Williams by virtue of inheritance, precept and example as well as through the very finest preliminary education has come prepared to assist in the solution of some of the most intricate of our problems. Fortunately by virtue of his resources as well as his love for and great capacity for the work, he has developed a research for us which has not been considered by others and up to the present has otherwise been quite beyond our reach.

Aside from the great value of his work, is to be observed the generous and earnest spirited manner in which he has given it. It is my opinion that in extending our appreciation to Williams we should also assure him of our unlimited confidence and endorsement of his work in the hopes of its continuance and belief in his ultimate reward.

(Writer's Note).—Due to the extreme lateness of the hour and the very important papers to follow, the writer made every effort to shorten the session by very hurriedly and informally performing routine tests on the instruments illustrated in this paper. These instruments, also the methods of conducting the tests, can be only of interest to metallurgists or one researching in the subject. It is believed in most instances that the photographs will give them sufficient information. Detailed information however will be gladly supplied to anyone who is interested.

Mr. Williams.—In reply to your first question you can obtain greater ductility in the majority of complex gold-platinum alloys by heating to redness and plunging. However, this procedure will decrease tensile strength. In order not to approach a condition in which a small amount of cold-work or vibration will fracture a wire, additional ductility might be desirable and it can only be obtained by heating to redness and plunging quickly.

Dr. Ketcham.—Afterwards we retemper or anneal by heating to redness and allowing to cool slowly. Is that proper?

Mr. Williams.—That is perfectly proper but you can heat, treat, or attempt to harden some of these alloys forever, and not a great deal happens. This brings up another point of interest. Most casting golds are complex alloys. They are subject to transformations at temperatures below their melting points. A certain well-known practitioner told me that his cast clasps were too pliable. The small occlusal rest on the top of the clasp was always pointing in the air. I told him to put his clasp on a hot plate and heat for a few minutes at five to six hundred degrees F. I was informed that immediately following this procedure the clasp stood up perfectly but after a month or so had elapsed, the occlusal rest again resumed its upright position. This would indicate that these intermetallic

compounds are not stable. How long they are stable and under what conditions will have to be determined by additional research.

In taking up the matter of a small testing machine to be used by the orthodontist, it is my opinion that an ideal condition would be attained if an organization were formed composed entirely of the technical staff of the various firms in this particular field. Some such instrument could be brought up and discussed to great advantage. The instrument that I have here, merely furnishes one method for quickly determining the elastic range. It can determine the proper heat-treating temperatures for the different alloys. There are undoubtedly many other methods for determining the same properties but, at the present time, I do not know of any instrument as quickly operated or as inexpensive. I imagine if your organization took it to the proper manufacturer, it could be produced in quantity lots as cheaply as five dollars each. I know that if I were practicing orthodontia I would find it difficult to get along without one of these machines. It seems to me as if you are more or less working in the dark. Certain gentlemen in your organization possess heat-treating furnaces that are never used, due, I believe, primarily, to the variable hardening temperatures of the different alloys.

Again I must remark that the hour is late and I do not wish to further impose upon your time.

From Weinstein's remarks, it might be inferred that our relations are not exactly cordial. This is emphatically not the case,—our relations have been friendly indeed for a number of years. Arguments of this nature invariably come up in any scientific discussion. However, I hardly believe that they should be argued before your organization.

I must answer in brief however, that on invitation from the New York State Society of Orthodontia I had the pleasure of hearing a paper delivered by Weinstein, also a discussion of that paper by Professor Chamot of Cornell University. The paper dwelt principally on the marked superiority of one commercial product over all others. It was also stated that photomicrographs of complex gold-platinum alloys could not be prepared. At the time, I possessed over one hundred of these photomicrographs. It was also stated that hardness was in no way related to elasticity or stringiness. Of course they are directly related. There were also chemical inaccuracies in the paper.

When all of this work is submitted to the Bureau of Standards for any possible assistance in their research, I would appreciate being permitted to forward this work, together with the previous work of Weinstein and the discussion by Professor Chamot.

I feel it my duty to defend the Rockwell Hardness Tester. I have used all of the other standard instruments but have brought this particular one to the meeting because of its sturdy construction, its accuracy and the quickness with which it operates. It is certainly of sufficient accuracy to demonstrate any points brought out in this paper. Criticism can only be due to lack of knowledge of the instrument, also failure to recognize a specially constructed anvil, ball and weight. I never use it on cross-sections smaller than .032.

The instrument for quickly determining bend strength is the idea of W. H. Bassett. I have made some changes to adapt it to our needs. Bassett is the technical superintendent of the American Brass Company and a nationally known metallurgist.

The instrument that I used for determination of the elastic range is infinitely more accurate than anything I have seen used heretofore. Professor Waite of the University of Buffalo has expressed a desire to use it in certain of his lectures on metallurgy. I might ask that you compare it with an instrument that was constructed by Weinstein.

The scleroscope might be subject to certain criticisms, but it is used by metallurgists and will continue to be used.

About ten years ago I carried orthodontia appliances in my mouth. The construction of that appliance was entirely different from the appliance of today. I have changed my ideas along certain lines and I believe that I will change them again. If I do not, of what use is any research?

At one time I mentioned that the greatest difficulty arose from faulty manufacturing, nonhomogeneous alloys, shrinkage, blow-holes, etc. I have spent a great deal of time on

this problem and believe a solution to be almost at hand. This information will also go forward to the Bureau of Standards.

This research work that I have been carrying on is not my effort alone. It is the result of advice and criticism received from a number of skilled metallurgists, the majority of them fellow members of technical organizations. I am also cooperating with manufacturers who are displaying interest in this subject.

In order to properly conduct the tests that I hurriedly ran through for you in a few minutes, there would be required a considerable outlay of time, also very careful manipulation of the instruments. I merely wished to demonstrate to you, roughly, the procedure that is normally followed.

I must admit that my research has been carried out on experimental materials; furthermore they will continue to be experimental while a possible chance of improvement in alloys or methods of manufacturing exists.

INFERIOR RETRUSION*

By W. H. Dolamore, L.D.S., M.R.C.S., L.R.C.P.

GRADUALLY, over the course of many years, it has been pressed upon me that superior protrusion, properly considered, is infrequent. It has seemed, as I watched these cases, that most of them which, as a student I was taught to regard as superior protrusion, and about which much has been written, are not so at all, but are cases of inferior retrusion. Fig. 1 illustrates this.

It represents a case that came the other day for a denture. The patient said that, when a child, her upper front teeth had been retracted. The lower incisors bite behind the upper ones, reaching almost on to the gum, but the lower premolars are in postnormal occlusion with the uppers. For aught I know to the contrary, the treatment by retraction of the upper front teeth may have been relatively successful and the facial effect of the present abnormal occlusion is masked by the patient having an unusually fat face. Nevertheless, it would appear certain that, as years roll by, when the upper front teeth begin to elongate, these must be forced out into that prominent position which the worst sort of Continental comic papers present as caricatures of an elderly Englishwoman.

The lower front teeth, biting upon the gum behind the upper teeth, force these in most cases to take up a position of undue proclivity. But I think this to be a secondary effect, and as having quite a distinct cause from those cases I regard as true superior protrusion. As a rule, however, it is this undue proclivity which is the arresting feature at a first glance. Often I have found that students diagnose the case as being this and this only, and the more readily because the underdeveloped condition of the child's nose is not remembered. Indeed, often parents when told of the essential fault are apt to demur to its correction on the ground that the mouth will be too prominent and the face disfigured.

Figs. 2 and 3 show the profiles of a mother and of her daughter. The latter is rather older than the age I am now considering, being fourteen years of age. In this case of postnormal occlusion the upper front teeth are retracted, and the first step in treatment has been to push them further forward before attempting to bring the mandible forwards. I have, however, no doubt that in time the girl's nose will develop to equal somewhat the prominence of her mother's, and will cause the lower part of her face to appear more retruded than now, unless the postnormal occlusion be corrected.

Fig. 4 represents a boy of four years of age. The diminutive nose and retruded chin are well marked. This case raises a point I should like to see investigated, namely, whether in all cases of postnormal occlusion of the permanent dentition this condition is present in, or foreshadowed by, the deciduous

*Read before the British Society for the Study of Orthodontics, Meeting of March 5, 1923.

dentition. My own impression, but it is not of great value, is that some cases at least do not develop till the change of the dentitions is in progress. If this doubt were definitely solved, one way or the other, light might be thrown on the etiology of the condition, concerning which I have nothing to offer.

Personally, I am at loss to explain the condition, and its cause seems to me to require investigation. One would like, in the first place, to know whether the mandible is, or is not, of normal size. For the purpose of discussion I assert that there is usually no diminution in its size, but I have no statistics to present to you. It would appear well worth while to have a very large num-

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

ber of measurements taken. But it would be necessary not only to establish an average standard size for the mandible, from which variations could be noted, but also, by some means, a proportional standard, to show its normal size relatively to the other facial and cranial bones. These measurements would give also the relative frequency of postnormal occlusion and show the age at which the defect begins to develop.

If the defect is not to be found in a variation of the size of the mandible, is it due to a malformation, or variation, of the articular surfaces of the temperomandibular joint?

In Fig. 5 are shown tracings taken from the glenoid fossæ of a number of skulls. These were taken in 1901 to illustrate the paper which Sir Charles

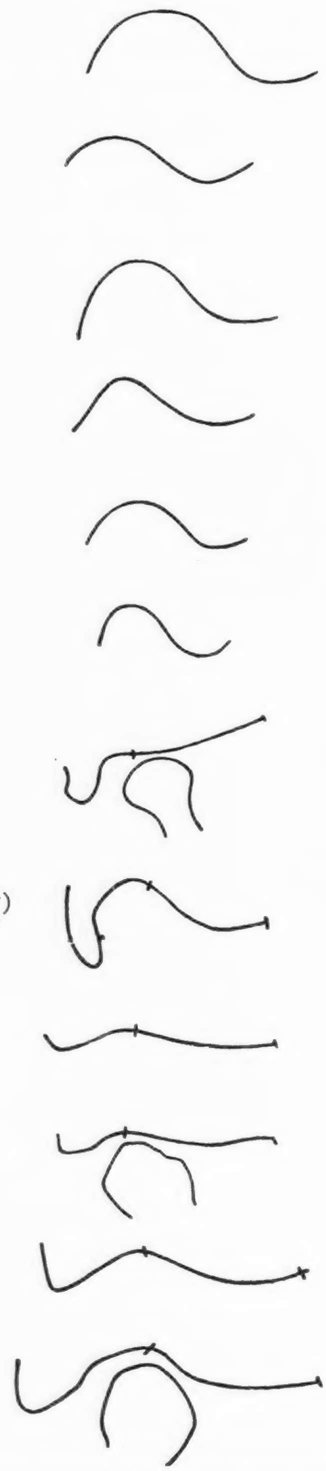


Fig. 5.—A series of tracings of the glenoid fossæ and eminentia articularis of man and certain apes.

Tomes and I wrote concerning the movements of the mandible. Some of these were taken from bodies in the dissecting room, and the bone surfaces were therefore covered by cartilage, while others are from dried specimens in the College of Surgeons Museum. They show a wide variation in the shape of the fossa mandibularis, or more correctly of the development of the tuberculum articulare. While the striking development of this in the "Howling Monkey" proves it to be a variation concomitant with the overdevelopment of the hyoid bone and related to a thrusting forward of the mandible during its depression to allow this to avoid the prominence in the neck caused by the hyoid. The more erect the head is held in man the more necessary is this forward movement of the mandible during the opening movement in order that the neck structures may be cleared, and Lubusch states that the tuberculum articulare attains its greatest height in civilized races. This variation would here appear to be a concomitant variation, but this does not necessarily seem to exclude the need for observations to see whether or not some aberrant abnormality of form of the articular surfaces is a causal, or at least a contributory factor, in ab-

Fig. 6.

normalities in the position of the mandible. Moreover, it is stated by Wallish that normally the condyle rests on the back of the tuberculum articulare and that normally there is no pressure on the floor of the fossa mandibularis. The actual position of the condyle in these cases is well worth ascertaining. From *à priori* reasoning it would seem clear that if Wallish's statement is correct then any cause, such as lack of relativity in the rates of growth of associated parts, might lead to the condyle occupying a more dorsal position, in other words to a posterior or dorsal displacement of the mandible. For we know that slight movement at the joint is associated with greater displacement of the body of the mandible, and I think it to be true that in all these cases the mandible does approximate the maxilla more closely than normal, since by raising the bite the appearance of the patient is improved. Such a dorsal movement of the condyle cannot, I think, take place unless the temperomandibular ligament is stretched, and I have found that it is very rare indeed for a person to be able to retract the mandible beyond the normal, though of this I have seen a few instances; but the movement even then was very slight.

Some time ago I called attention to the fact that if a number of teeth in the maxilla and mandible be removed, then for some few days afterwards the

upper and lower gums cannot be brought into contact, but that after a while they can be. Overclosure of the mouth is not possible unless the condyle can move dorsally beyond the normal, and this again is not possible unless the temperomandibular ligament is stretched. It must be assumed that the latter does stretch under the constant strain of the attempts to approximate the gums. This seems to be proved by the fact that if, after it has stretched, the patient wears artificial dentures, and hence the strain be removed, then the ligament will again contract and the gums can no longer be made to meet. It seems to me that it is on a similar contraction that we must rely, at any rate in the first instance, to help us in the treatment of these cases.

It is not necessary to describe the ordinary clinical features of these cases. The desideratum in treatment is to persuade the patient to bite forwards and to cause, or allow to develop, a condition which either will prevent the mandible moving backwards or will render the forward bite so much more comfortable that the patient will naturally and habitually place the mandible in this position. If this latter can be attained, then on the preceding reasoning it follows that the temperomandibular ligament will contract and that then the former dorsal movement of the condyle will be impossible. For all practical purposes nothing else is necessary though it may be assumed that in the course of time other structural changes may take place in the form of the articular surface.

Years ago I treated periodically a boy during his school years. The articulation of the upper and lower teeth was perfectly normal. In course of time he entered the Army and was stationed at a distance from London so that I ceased to see him, but upon a visit of his mother she told me that his jaw had become underhung. The question arising of what could be done to treat this deformity the patient, upon a visit to London, called upon me. I found the condition to be as described. The mandible bit forwards, the lower incisors being in front of the uppers, the premolars and molars were in good working occlusion though in prenormal position. Mr. Matheson also described a similar case though I am unable now to give a reference to it. I am persuaded that the cause of the development of this condition was the overeruption of the wisdom teeth. This eruption is frequently accompanied by tenderness of the overlying gum, due to the pocket the latter forms becoming filled with septic matter which, following a trauma during mastication, infects the tissues. This tenderness naturally induces the patient to bite in a forward position since this is the only way by which pressure on the gum can be avoided. I conceive, in these very rare cases, this forward bite becomes habitual and that, therefore, the wisdom teeth do not come into occlusion until they have overerupted. In other words, when the tenderness of the gums has passed, or more correctly when the gum over the teeth has been absorbed, the forward bite ceases to be one of convenience but, because of the overeruption of these teeth, becomes a mechanical necessity if the other teeth are to be brought into occlusion. I am, myself, convinced that neither in this case nor in the cases about to be described, have the teeth moved bodily forwards in the mandible as has been suggested.

Following this reasoning the treatment I have tried is to obtain overeruption of the second molar teeth. It is essential to distinguish between what, for

lack of a better nomenclature, I venture to call physiologic and pathologic overeruption. The case just described was a physiologic overeruption. The ordinary physiologic forces, be they what they may, were at work. Within limits, a tooth erupts until it meets its fellow and then the alveolar bone develops around it and fixes it in this position. If this takes place we know the tooth

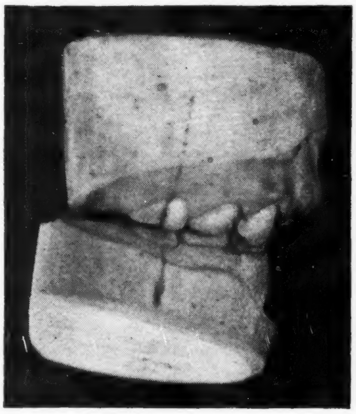


Fig. 7.

Fig. 8.

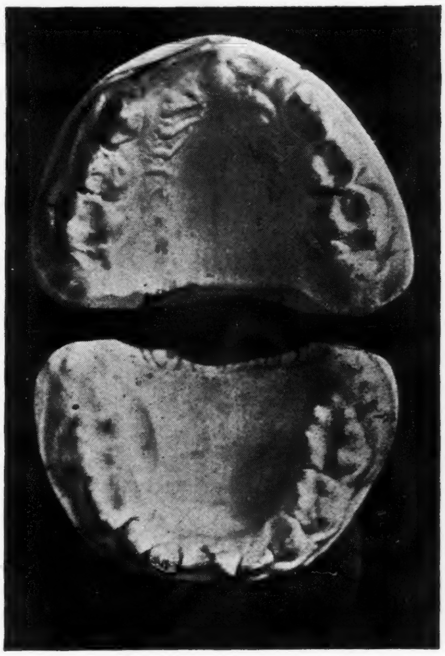


Fig. 9.

will resist the force of mastication—for if it were not so the first molars would, upon early loss of the deciduous molars, be bitten back into the bone. This physiologic elongation differs from the pathologic, since the latter depends essentially upon the thickening of the alveolar periosteum, or upon the contraction of the alveolar dental ligament. If the appliance which permitted or caused these conditions to arise be removed, then the soft tissues have not sufficient resistance to prevent the tooth, or teeth, being bitten back to their

previous position. This conception does not ignore the possibility of the alveolus developing around the tooth when pathologically overerupted, but it conceives this to be a slow process, so slow and uncertain as to render it unreliable as an assistance to curative efforts. This, if I have read correctly, is the experience of most, and justifies the view often expressed that cases, treated on the basis of pathologic overeruption, usually relapse.

Fig. 10.

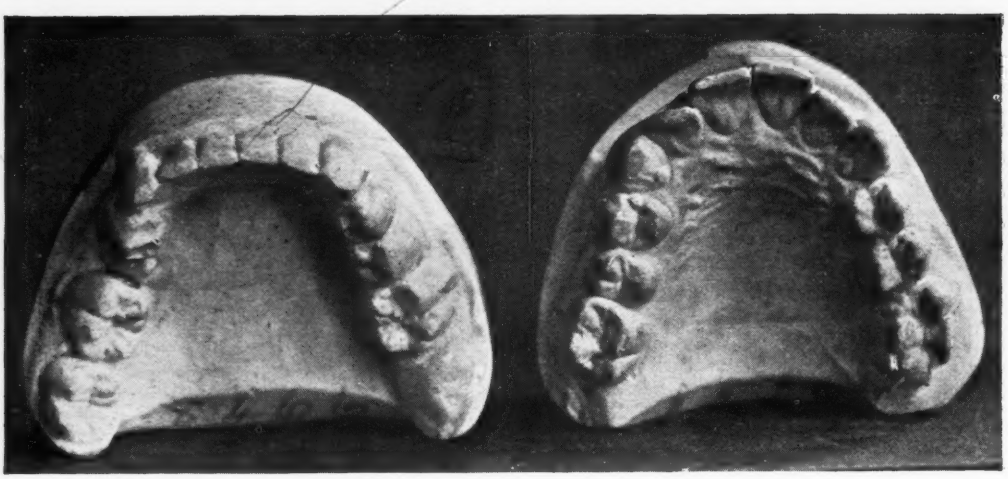


Fig. 11.

The first condition, therefore, necessary to success is that the treatment should be undertaken at a time when we can allow, or cause, a physiologic overeruption. In other words, in my opinion, we are not justified in commencing treatment except during the eruption of either the first or second molars. It happens that all the cases I have treated have been during the second period.

This method I have now tried for several years and with a large measure of success. It is not put forward as a panacea. Failures will occur, but I

am more inclined to regard these as due to faulty technic rather than to any fundamental error of principle. There are also cases which are complicated by unilateral forward movement of the molars, often due to early loss of the deciduous molars due to their early neglect, caused in hospital cases by the total inadequancy and often inefficiency of the work in school dental clinics. The method has this great advantage, that in the forward position the lower

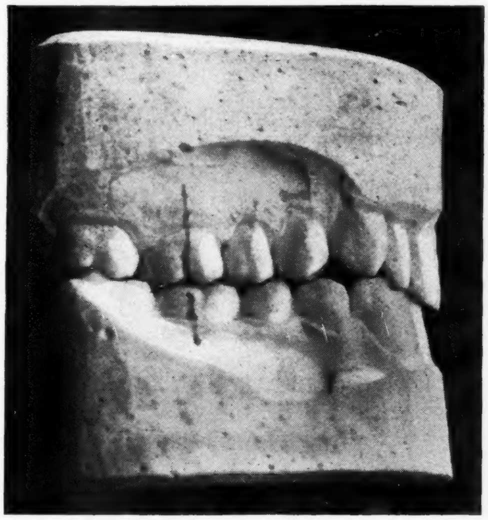


Fig. 12.

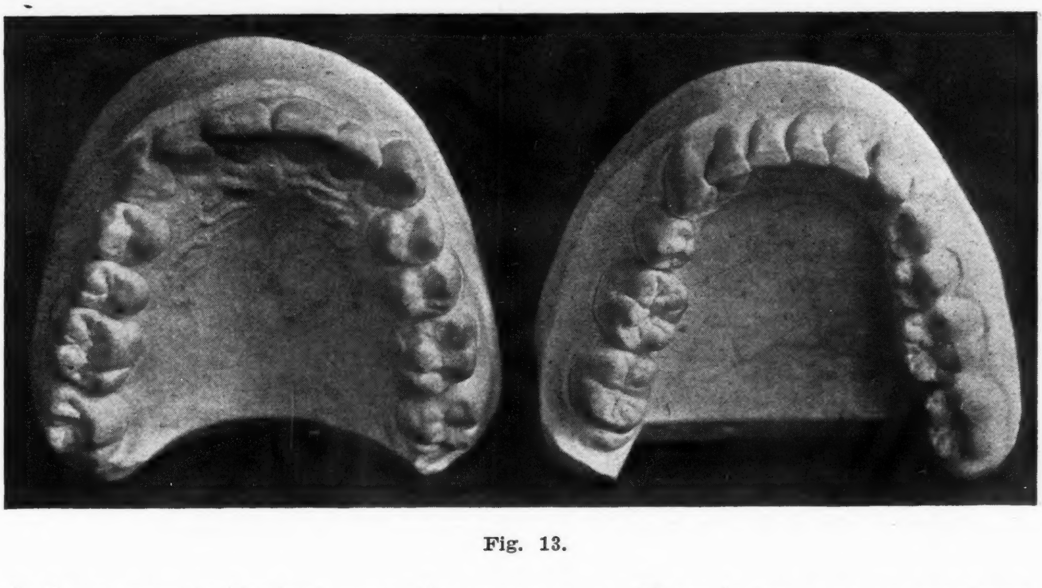


Fig. 13.

incisors cease to impinge upon the upper gum. There is room, as an accessory measure, to correct the undue proclivity of the upper incisors. It avoids that cruel and crude method of obtaining space by grinding down the incisive margins of young and sensitive teeth.

In almost all these cases when the mandible bites forward it is apparent that the upper arch is too narrow to allow normal occlusion of the molariform teeth in this position. My first step has always been to expand the upper arch,

and for this purpose I regard the use of the Badcock screw to be the best and simplest method. The raising of the bite can be commenced at once by capping a molar, in my cases the first permanent, with a metal cap. For capping one tooth vulcanite has not proved to be sufficiently strong, and although our reliance is placed upon the elongation of the second molar there is no obvious reason why the premolars should not be allowed, at the same time, to rise up and move down. This plate, as Badcock demonstrated, can be made with an inclined plane. Only a relatively short time is necessary to obtain the expansion, and then a simple plate with an inclined plane and metal molar caps is inserted. Thereafter we have simply to wait till Nature does what we wish.

The models shown are chiefly from the Royal Dental Hospital. It was the coincidence of there being this little group in various stages of treatment and the assistance of the demonstrator, Mr. Evans, who kindly collected them together, that rendered it possible for me to show them to you.

Fig. 14.

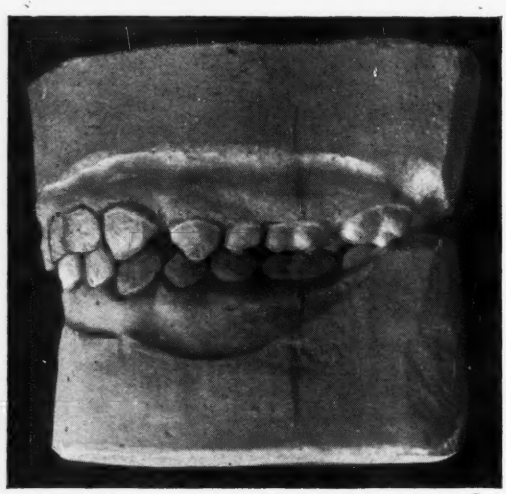


Fig. 15.

Figs. 6 and 7 show a case of inferior retrusion in a boy of four years and five months of age, who is under the care of Mr. Pitts, and to whom I am indebted for the loan of the models. Figs. 8 and 9 show the dental arches of the same case. The narrowness of the upper arch compared with the lower is well marked. There would not appear to be any advantage in commencing treatment till the first permanent molars are about to erupt, and the absence of incisor teeth would seem to deprive the child of any motive to bite forward. In my experience a willingness, or rather a desire, to bite forwards is an important factor in obtaining a good result.

Fig. 10 shows the models in occlusion of a boy of about thirteen years of age taken in February, 1921. It is a case of marked inferior retrusion with the teeth in postnormal occlusion and the lower incisors biting on the gum behind the upper teeth. Fig. 11 shows the same models placed side by side to illustrate the narrowing of the upper arch. Fig. 12 represents models taken in December, 1922, when the treatment was regarded as complete, although the premolars have not yet come into absolute occlusion. Fig. 13 shows the same models placed side by side. The displaced second lower premolar left was

extracted at an early date. This I regard as one of the most perfect results we have obtained. The boy was intelligent and willing, and the dresser, Mr. Bernard Ridot, took considerable pains. This boy cannot now retract his mandible, from which I infer that the temperomandibular ligament has contracted. Of the boy it may be truly said that we have transformed his face from that usually regarded as representing a weak, indeterminate character

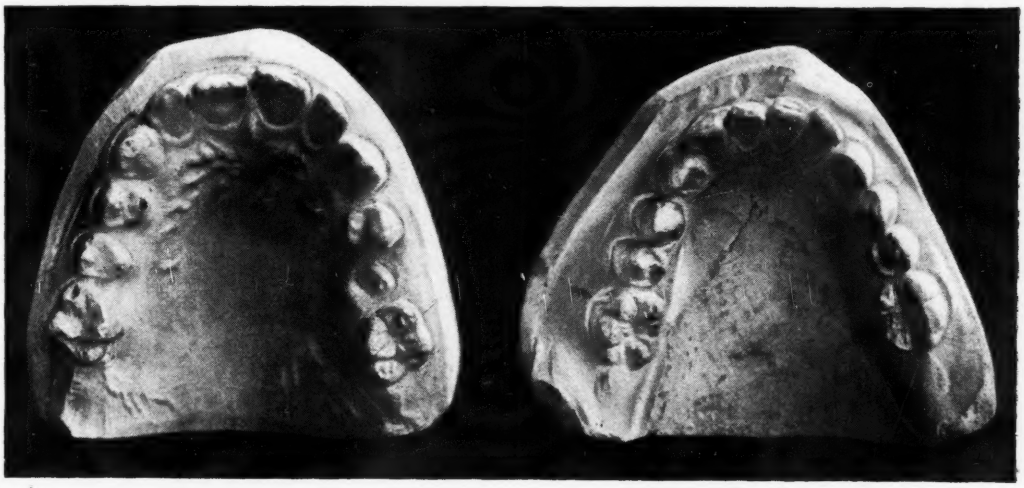


Fig. 16.

Fig. 17.

to one betokening firmness and will. It would seem fair to assume that as years go by this character will be attributed to him, and indeed the psychic effect may be that so it will develop.

Fig. 14 shows another case, a little girl, and Fig. 15 the same case after treatment. This happens to be a private patient, and the mother was concerned lest the mandible should prove to be unduly prominent, but was reassured on my asking her to compare the size of her own nose, which happens to be somewhat large, and that of her child. Figs. 16 and 17 show the models

placed side by side. The lower front teeth have been forced outwards by the inclined plane. This is often an accessory factor in completing the correction of the deformity.

One of the most difficult cases I have been asked to treat is shown in Fig. 18. There is undoubtedly diminution in the size of the mandible and the case was further complicated by the first molars being so hopelessly decayed that their removal was obligatory. Even after treatment had proceeded for two or three years, and while wearing a plate with an inclined plane, her mandible when much depressed moved backwards to an astonishing degree on opening the mouth, and at one period of the closing action a distinct step was seen as the patient, more or less involuntarily, moved the mandible forward to allow the mandibular teeth to occlude with the maxillary in a normal position. Up-

Fig. 18.—A rephotograph taken from among a group in an old photoprint. Much enlarged.

Fig. 19.

on one side, after many years, the second molars occluded, and the closure was normal, but upon the other they had ceased to rise. I, therefore, artificially elongated the lower tooth by means of a cap crown anchored by a button in a coronal, carious cavity which had developed. The effect of this elongation upon retaining the mandible in normal occlusion is very marked, and seems to justify the previously expressed contentions with regard to this matter. The patient and I trust that later the third molars may overerupt and complete the treatment. Fig. 19 represents the patient when "on parade," if the expression may be allowed, and indeed the improvement is remarkable, but the curious step-like movement of the mandible still persists upon extreme opening of the mouth. This patient is extremely tall. In estimating the value of treatment the growth of the child must be considered. A retreating chin when looked down upon is not nearly so abhorrent as when the face is on the line of

vision, and far less so than when, as in this instance, the average person must needs look up at it.

I have purposely omitted a written account of many cases shown at the meeting. Without an excessive number of illustrations the description of them would be impossible. The models of my private cases were thrown away upon moving my professional quarters, when in one wild, but joyous, moment I cast away the litter of years.

DISCUSSION

The President said Mr. Dolamore had given the members a great deal to think about; his paper had been exceedingly interesting. It was of particular interest to him personally, because a year ago he had read a paper embodying practically the same conclusions as those to which Mr. Dolamore had come, although he himself was inclined to treat the cases at a somewhat earlier age. Mr. Dolamore's paper contained a great deal that was not present in his own, but the actual lines of treatment were very similar. With regard to what Mr. Dolamore had said in the earlier part of his paper as to the terms "inferior retrusion" and "superior protrusion," a perfect classification had yet to be found. The terms in question were old, and he supposed they would continue to be used until they became absolutely obsolete. The term "postnormal" was always used, yet what "normal" signified had yet to be defined. He thought the terms were sufficiently well understood. The paper was full of interesting points; that in regard to the glenoid fossa was particularly interesting and gave much food for thought. Mr. Dolamore also referred to the examination of dissecting room specimens, but personally he thought that might not be of great value; so many of them were from subjects who were so old that the examination of the joint would prove of very little value to us.

Mr. Dolamore said he had seen bodies in the dissecting room with normal dentitions, but he admitted it would be difficult to get them. He did not see why one should not get them in the postmortem room, because it might be possible to turn up the face without deforming it.

The President agreed that could be done. What Mr. Dolamore said about the stretching of the ligament might be an explanation. The mechanism of the joint needed to be examined very carefully in order to determine which part of it was stretched. It was perfectly true, as Mr. Dolamore said, that if the teeth were extracted the jaws could not be brought into contact. With regard to the appearance of a child, the proportions of the face in a child with the mandible displaced or not advanced caused an appearance that was pleasing to the parents, the features really becoming balanced at so early an age. To alter that appearance often meant, as Mr. Dolamore said, that the mother would bring the child round and say its beauty was being spoiled. Most orthodontists would have experienced this. He agreed almost entirely with what Mr. Dolamore had said, but personally he would be inclined to commence the treatment at an earlier age. He had found, like Mr. Dolamore, that the children were unable to retract their jaws after establishment of the condition desired.

Mr. Highton asked whether, in constructing the plate, Mr. Dolamore capped the six year molar only, and whether he had any difficulty in that connection if the molar was depressed, or whether he capped the premolars as well as the six year molar.

Mr. Steadman had been very interested in what Mr. Dolamore had said about cases of superior protrusion, which was really in opposition to what was taught in certain quarters. He thought there were certainly some cases that must be put down as postnormal, but it was extremely difficult to tell whether to diagnose between a postnormal occlusion or superior protrusion, and he would like Mr. Dolamore to give some guidance on that point. As was stated in the paper, the mandibles seemed to be very normal when in fact they were definitely postnormal. The point which struck him most was the difference between patho-

logic overeruption and physiologic overeruption. That was a most important point, and no doubt accounted for the fact that many people who tried to bring the mandible forward failed, since the whole thing went back so quickly.

Mr. Harold Chapman entirely endorsed Mr. Steadman's remarks in regard to the paper. One point occurred to him in connection with physiologic and pathologic overeruption of the teeth, namely, that if Mr. Dolamore waited until a child was twelve years of age in order to produce the physiologic overeruption, was it not necessary for the teeth which had already erupted—the first permanent molar and all the premolars—to overerupt pathologically, in order that they should come into occlusion? He would like to hear Mr. Dolamore's opinion on that. Another point on which he would like to hear Mr. Dolamore's views, and which was really the same question in another form, was as to whether he thought the treatment of the girl whose case he had shown last would be as successful as that of the child whose models had been shown first, one being aged twelve and the other about six. He had mentioned at the Council Meeting earlier that evening that Mr. Friel had asked him to suggest to the Council that they should make some suggestions as to lines of work on certain problems which the members might investigate in connection with their work. It seemed to him that Mr. Dolamore had offered some very valuable suggestions in that regard, and he sincerely hoped the Council would formulate some questions which all the members could investigate quietly during their daily work, and the total results of which would be, he thought, extremely valuable.

Mr. W. J. May thought the best time to secure physiologic overeruption would be about the age of seven, for then one could get physiologic overeruption of the six year molars by capping the temporary teeth. He would like to know what experience Mr. Dolamore had in treating children of that age; most of his models were of older subjects.

Mr. Schelling said that the previous week he had treated a case on the lines indicated by Mr. May. Eight or nine months ago he put in a plate very similar to that mentioned by Mr. Dolamore to allow the lower incisors to come forward, and possibly to shorten. The plate had now its desired effect, and he had removed it. The child was now about seven years old, and he proposed to wait for some years before doing anything else.

Mr. Packham thanked the author for his extremely interesting paper, and commented on the frequency of the condition dealt with. It almost seemed as if every child one saw had some degree of inferior retrusion. That led one to wonder what the cause of it might be, and it had occurred to him that possibly it was a question of two things, mouth breathing and function. With inferior retrusion of the mandible, if a child bit with it in that position that bite would be an inferior one from the point of view of function. A person suffering from the deformity in question could not bite or chew his food so well as one with normal occlusion. That was brought out when one made dentures on the Gysi three-point articulator: in those dentures one nearly always found that the lower incisors had to be almost edge to edge with the upper incisors. If with inferior retrusion the bite was a less functional one than with normal occlusion, what was the cause of that? It seemed to him the whole thing was bound up with the fact that we did not use our teeth as much as we used to, and Nature said, "You are not giving your teeth as much work as I have made them to do, and therefore I will give you a less functional bite." If one could get children who one thought were likely to have this condition to gnaw and chew to a greater extent, the trouble might be largely overcome. On one occasion he had had a boy brought to him whose parents were very disturbed because he would never chew anything. At two years of age—he was now five—he would take a piece of meat in his mouth and, rather than chew it in small pieces, he would deliberately go to sleep with it in his cheek. A biting plate was fitted to bring the mandible forward and allow the first permanent molars to erupt, and now the boy bit the plates to pieces. He had already got through three plates! It seemed to him, therefore, that function was really an important factor in the etiology of that condition, as well as in mouth breathing. He would like to ask Mr. Dolamore what evil results followed the nontreatment of such cases. Most of the cases Mr. Dolamore had shown had been of a very pronounced type, but one met with many

cases which were not so pronounced, and which made one wonder whether or not to interfere. Sometimes the mother would say, "This boy is perfectly comfortable; he can chew the food he is given; why interfere?" One could, of course, expatiate on the beauty point, and on the fact that perhaps he would not get into Parliament, but what else was there to be said? He would like Mr. Dolamore's view on that. Perhaps Mr. Dolamore would also be kind enough to elaborate somewhat his reason for the contraction of the upper arch.

Mr. Newbold, referring to the case of the boy who went into the Army and grew third molars with a forward bite, asked whether Mr. Dolamore had seen him since and could say whether his other teeth had come down and met.

Mr. Harold Chapman said the last two speakers had suggested certain other points he would like to mention, although they hardly referred to Mr. Dolamore's paper. He thought habit might be bracketed with function as a cause of malocclusion. He had been told recently, although he did not know what authority there was for the statement, that unless a child learned to suck in the first two or three days after its birth it would be very difficult for it to do so, and it probably would not do so in the correct physiologic manner. The same applied, he was told, to chewing; if a child did not learn to chew at the right time, immediately after weaning, it was very difficult to train him to masticate his food correctly. The child Mr. Packham referred to had probably never learned to chew at the right time, and it had now had to be trained to do it instead of learning to do it in the normal way. With regard to the other case referred to, he had a child at the hospital recently who was about three years of age. The mother was a Class III case, and she noticed that the child was also in the same condition. She must have been a very intelligent woman, since it was scarcely obvious in the child. She was anxious that her deformity should not be repeated. He told the mother she should endeavour to make the child practise getting her lower jaw behind. When he saw the child three weeks later, it was biting normally.

Mr. Stordy said Mr. Dolamore had mentioned the drawing forward of the jaw. He would like to know whether that drawing forward was actually due to the sliding of the alveolar portion on the body of the jaw, or to a change in the joint. If it was due to the former, the results were likely to be much more permanent than if it was due to a change in the joint; if it was due to a change in the joint he feared there would be a relapse to the original condition after a time.

A Member asked what happened to the condyle when the lower jaw was brought forward. Normally, in the case of a child of ten, or any child which had not attained full growth, the mandible was tending to grow backwards; at any rate, it had got to grow to its normal size, and he did not see why the condyle head should not grow backwards as well. When one pulled the lower jaw forward, the head of the condyle was naturally in advance of its normal position of rest, and he did not see why it should not grow backwards until it got into its normal position.

Mr. Dolamore, in reply, said he entirely agreed with the President that the proper moment to treat cases was undoubtedly when the deciduous molars were in place and the six year molar was about to erupt, always provided that the deformity existed at that period. On that he had very little evidence to offer. In the case of the little child who was his own patient, he certainly did not notice the deformity when the deciduous teeth were in place. It might be that the fault was his, that it did exist and he had not noticed it; but he wondered whether, in some cases at any rate, the deformity did not arise during the eruption of the permanent teeth. That was a matter which a Society such as that he was addressing might well investigate, and was the reason he suggested investigating the teeth at such an institution as the Foundling Hospital, where, in view of the number of postnormal occlusions one saw in an Out Patients' Department, it was reasonable to presume there must be a considerable number of such cases at the time when they should be treated—if they were then in existence. On that point he would very much like to have more information. One point he omitted to make in regard to the treatment he advocated was the comparative ease and inexpensiveness of it, which placed it within the reach of

quite poor people. There were only two or three plates to make. First of all there was the expansion plate, which one might hope would do all that was required. If it did not, a second expansion plate might be necessary. A child could turn the screw of Badcock's expansion plate himself; it was not necessary for the dentist to see it often. Then another plate with an inclined plane must be put in, which must remain until the treatment was almost complete, when a retention plate was inserted. It seemed to him that if the method he advocated was as successful as he hoped it was and claimed it to be, it put within the reach of quite poor middle class people the possibility of having such deformities corrected, a thing they would be unable to do were the treatment elaborate and expensive. With regard to capping the teeth with an expansion plate, he was rather inclined, especially in cases where he wanted the teeth capped, to cap the premolars as well as the molars, chiefly because he held that if the plate was to work it must go home with a click and stick there; otherwise when the screw was turned the plate dropped down and the teeth did not move. Afterwards he only capped the six year molars, and for that purpose he generally had a metal cap made, because quite obviously a vulcanite cap would be constantly breaking and a source of worry and annoyance, whereas a metal cap would almost last until the teeth had overerupted. He freely admitted that his division into pathologic and physiologic overeruption was open to criticism, and he admitted that over-elongation of the premolars might always be described as pathologic. A twelve year old molar elongated physiologically, however, was going to stand stress. It was obvious that, taken over a period of years, a tooth did elongate; his point was that elongation by pathologic process was so slow that one would have to wait years to be able to put the stress on it, if there was not a tooth which was elongated physiologically to take the strain off those which elongated pathologically. With regard to the case of the boy who went into the Army, unfortunately he was killed; but as a matter of fact there was no need for elongation of the teeth in his case, because, as had been explained, he bit forwards to avoid the pressure on the the back teeth, and consequently his premolar teeth were in occlusion. One could find, by putting one's lower jaw forwards that one avoided pressure on the back teeth, but these teeth would be in occlusion. There might be some adaptation, but he did not think any great elongation was necessary. In London, at all events, the number of people one saw with slight posterior occlusion was very great, and one had to make up one's mind whether the deformity was sufficiently great to need treatment or not. One was apt, he thought, to take too short-sighted a view, and to regard a slight deformity from the point of view of the child up to, say, twenty-five years of age, forgetting that twenty-five was only the beginning of life and that, on the average, the teeth should last some thirty-five years longer. He doubted whether it was right to lose sight of what might happen after the age of, say, forty-five, when the teeth began, as they would, to elongate. It was conceivable that even with slight inferior retrusion it might be desirable and worth while to raise the bite slightly. After all, it only meant a vulcanite plate with a gold cap over a couple of teeth, and in six months the whole thing would be over. It was simple and inexpensive, and it was conceivable that it might be worth while treating slight cases in childhood, not with regard to the earlier period of life but to what one thought might happen after the age of forty-five or so. It was quite obvious that where there was an edge to edge bite, the teeth would remain firm for years longer than if there was overlapping. He remembered that once while acting as locum before he was qualified (a thing which was allowed in those days) he saw a patient, who was then eighty years of age. He had an edge to edge bite, and his teeth were firmly implanted. He celebrated his eightieth birthday by running races with his yokels, so that not only were his teeth firmly implanted but it might be assumed that that had contributed to his health and so prolonged his life. Taking a broad view, therefore, it might be worth while to treat small cases of overlapping in children. He had been asked whether the change was in the jaw or in the joint. He thought there could be no question but that it was in the joint. He did not think it would be possible to produce a change in the alveolus in a couple of years such as had occurred in the completed case he had shown. It must be remembered that, even if it were necessary for the joint to be remolded about the head of the condyle, it was perfectly possible for it to occur. It was well known that a child with a dislocated hip could have

a new joint molded around the dislocated head of the femur, and, if that could take place, why should not the glenoid fossa fill up around the head of the condyle? It seemed to him perfectly reasonable to expect it to do so. Whether the description given by Quain, that the head of the condyle rested on the back of the glenoid eminence, was correct or not hardly mattered; if it was, one would not need to get the molding; if it was not, the joint could be altered. At all events, the point was that to begin with it was a bite of accommodation. If one obtained a comfortable bite then the child would adopt it. The same thing occurred in cases of inferior protrusion, where the incisor teeth needed very little pushing out, but the child protruded the lower jaw more than was necessary. One could often push the jaw back so that the teeth came edge to edge, and a very slight movement forwards of the incisors corrected the difficulty. That was another instance of a bite of accommodation. He had mentioned that many London children suffered from inferior retrusion. It seemed to him that some investigation was needed into the different forms of malocclusion—and normal occlusion, possibly—occurring in different parts of the country. A short time ago he had had to go down to a school clinic at Derby, and it struck him that the children's arches were distinctly different from those which he saw in hospital practice in London. Derby was a limey district, and he could not help thinking that the arch was distinctly different from London types. He saw cases there of slight superior protrusion in which there was no inferior retrusion. He would like to see some investigations made with regard to the different types of bite and different types of occlusion which occurred in different districts. With regard to the narrowing of the upper arch in most of the cases of inferior retrusion, which he had seen, it was found, on putting the mandible forwards, that the lower arch was too large for the upper, and it was necessary to expand the upper to get normal occlusion. He could not explain it; he could only say it was so. In conclusion, he thanked the meeting for their patient hearing, and hoped that those who had not tried the method he advocated, would do so.

ANOMALIES OF DENTITION—MISSING TEETH AND SUPERNUMERARY TEETH*

By T. M. Robertson, D.D.S., Coffeyville, Kansas

In attempting to determine the etiology of the frequent cases of "absence of teeth" or cases where "supernumerary" teeth are present, we must of necessity investigate the conditions and environments surrounding the "cell life" of the individual before birth.

When we recall the early date at which the tooth germ appears in the embryonic life, the enamel organ of the deciduous set at six to ten weeks of fetal life, and the appearance of the enamel of the permanent set at the early stage of sixteen weeks, we realize that the diet and normal metabolism of the mother is the big factor in the normal development of the child's teeth.

We know that all "cell life," whether animal or vegetable, requires the presence of certain mineral elements for its growth and development; furthermore we know that certain of these necessary elements must be present in certain definite proportions if we are to get the normal chemical metabolism of normal growth. Experiments on animals have shown us that disintegration and death follow the forced feeding of foodstuffs deficient in these minerals necessary to the existence of life.

*Read before the Southwestern Society of Orthodontists, January 24, 25 and 26, 1924.

Health is a comparative term. The further we get from the natural foods, the whole grains, the natural raw fruits, vegetables and dairy products, the less health we have. Someone has termed man the "sickest beast alive"—mainly due to our demineralized, devitalized menu.

When the cells are starved, we find that in the case of the teeth, the last of the series fail to develop, the lateral, the second premolar, or the third molar. Nature is always eliminating the organs as the functional activity is diminished.

Several slides were shown of missing laterals, treatment being to restore the normal space and supply the missing tooth by attaching to pontic canine with rests on the lingual of central incisors to prevent rotation.

Fig. 1 shows the mother aged forty, one daughter aged eighteen, and one daughter aged sixteen, each with both maxillary laterals missing. The

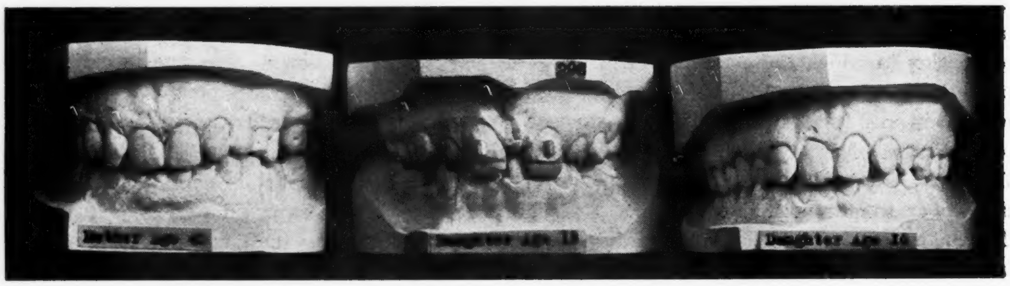


Fig. 1.—Mother, age 40, superior laterals missing. Daughter, age 18, maxillary laterals missing—also permanent canines missing. Daughter, age 16, maxillary laterals missing.

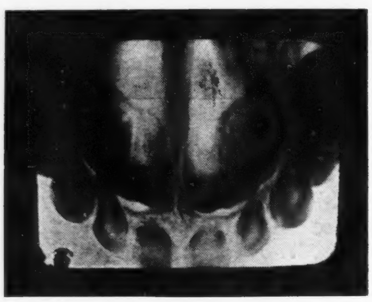


Fig. 2.—Son, age four, maxillary laterals present in both deciduous and permanent sets.

history of both mother and daughters shows a heavy protein diet and practically no fruits or vegetables. Living in a small town in the short grass country, with a barber as a provider, the mother said she was compelled to live on eggs and pork, produced on their own land, as they had no money to buy anything else. The mother reports having been born under similar environments. A third daughter aged fourteen had laterals present, the right slightly smaller than the left. The mother's diet was reported as nearer normal during this period, containing plenty of vegetables and fruits with less proteins.

The radiogram (Fig. 2) of a four-year-old son born later under better dietetic conditions and of a different father shows both deciduous and permanent teeth normal.

We might be inclined to say "Heredity," but the more I have inquired into the diet of the mother the more I am inclined to credit the cause to the depleted condition produced by faulty diet.

A NEW APPLICATION OF COUNTER-SPRING CONTROL IN THE REDUCTION OF A MALOCCLUSION, CLASS II, DIVISION I, FOR A PATIENT EIGHTEEN YEARS OF AGE, WITH ONE APPLICATION OF FORCE IN NINE MONTHS

By Henry C. Ferris, D.D.S., New York

THIS is a report of the treatment of a case of malocclusion Class II, Div. I (Angle) for a female, aged eighteen years, in which one application of force was applied, based upon an engineering principle.

The power was supplied with two springs, one lingual and another labial, being attached to the premolar bands with a hinge-joint. Both springs operated in the same direction for a period, then the labial spring became neutral, because of the distal movement of the central incisors which were acting as a fulcrum to augment this spring action.

The lingual spring did not come in contact with any teeth. It was set for an expansion of 2.5 mm. on the right side, and 2 mm. on the left, making

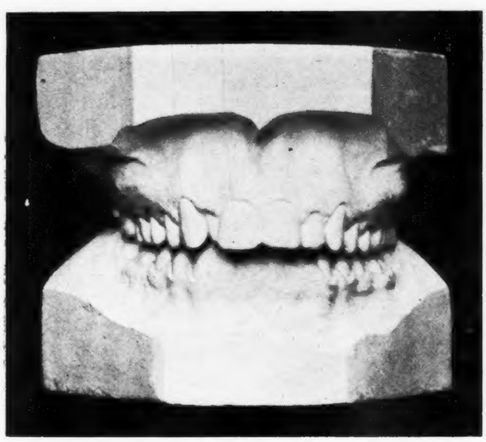


Fig. 1.

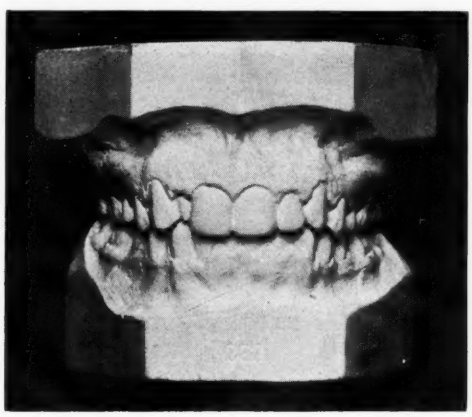


Fig. 2.

a total of 4.5 mm. This difference in set was made on the medial line with the right arm of the spring being 1 mm. longer than the left.

Mechanically, this would appear to be a violation of the principle of action and reaction being equal; but in this case, it proved to accomplish the desired biologic result.

In the absence of an explanation, it appears to me that the longer section of the spring from the central loop resulted in the breaking down of the osseous resistance, through the elastic property of the wire which was brought into action by the oscillation of the teeth in mastication. This caused

*Given before the American Society of Orthodontists, Kansas City, Mo., March 18-21, 1924.

the teeth to move faster on the right side than those on the left, as was desired.

The labial spring was first set to expand 4 mm., bent on a model with the central incisors removed, and was of sufficient length to form the curve desired when neutral. When this was placed in the mouth, its center rested upon the central incisors, which increased the expansive spring 1 mm. or a total of 5 mm. In the initial stages there was a total of 5 mm. plus 4.25 mm.

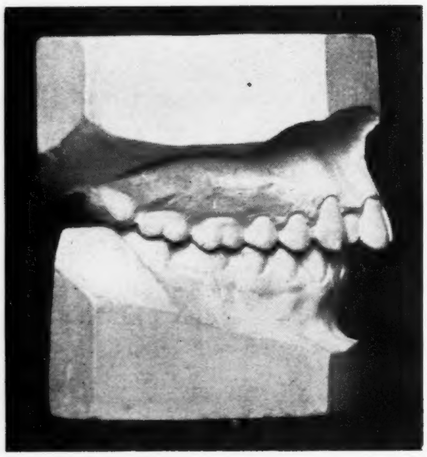


Fig. 3.

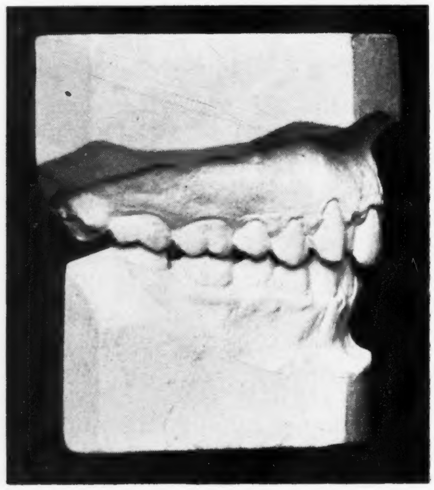


Fig. 4.

Fig. 5.

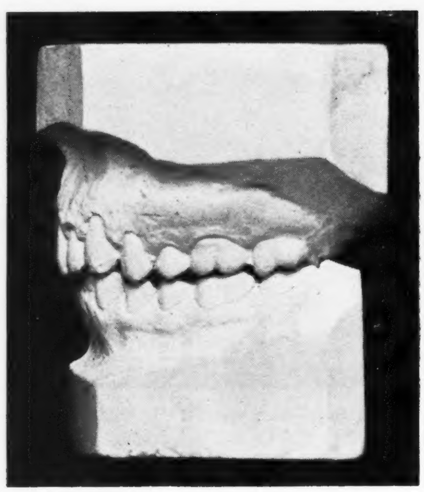


Fig. 6.

expansive spring power. At the completion of the expansion, the lingual spring was exerting .25 mm. expansion action, and the labial spring was neutral, which acted as a resistance to this expansion, and resulted in an equilibrium of forces which operated as a retainer of the teeth in their final position.

The vault arch was set with an expansion of 2 mm. brought about by bending buccally the section of the wire which was forced into the perpendicular tubes on the molar bands. The bands on the teeth were con-

nected with wire of the same gauge in soldered joint, extended to engage the canines. The tubes to hold the lingual spring were soldered to the wire distal to the first premolars or 12 mm. forward of the molar tube on the right side, and 13 mm., forward on the left. The six perpendicular tubes, three on each side, maintained the perpendicular axis of the teeth, and the two lateral halves of the arch rotated on the two molar tubes as centers, which were stabilized by the vault arch.

The labial and lingual springs were made with heavy spring elastic wire (NEY-ORO "E" .038) which fitted into heavy lumen tubes (NEY-ORO No. 3, .038 X .13). The vault arch was made of two pieces of .038 wire soldered together, which was held into position with latch springs. Soldered bands were placed upon the mandibular first molars to which was soldered a lingual arch set for an expansion of 4 mm.; buccal hooks were soldered

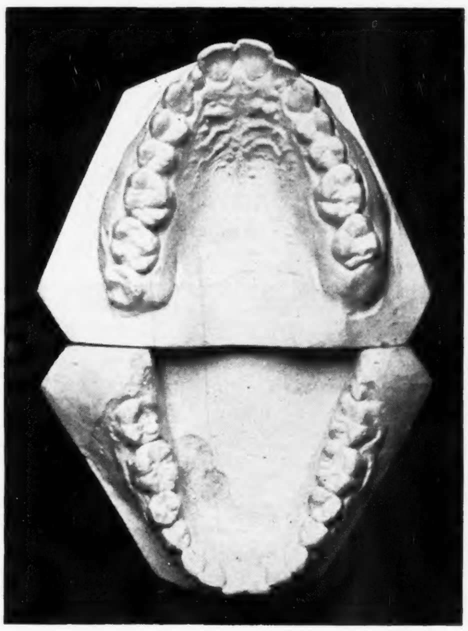


Fig. 7.

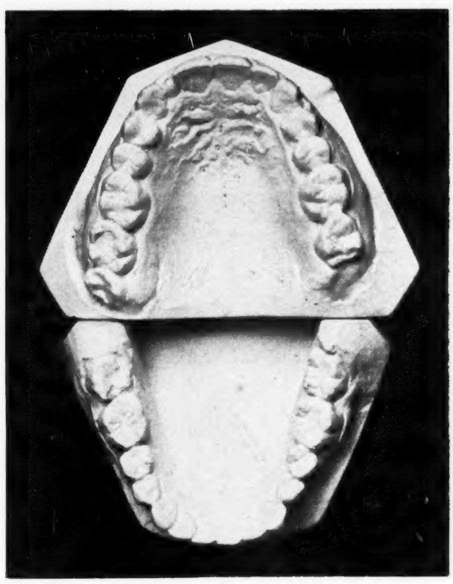


Fig. 8.

to these bands for the use of intermaxillary elastics, the anterior end of which engaged the hooks on the labial arch superiorly. Auxiliary springs were attached to the lower arch to move the left inferior lateral incisor and canine labially.

The patient left my office on October 2, for a foreign country, and returned the following year on June 22. This patient had no professional attention during this interim.

Upon examination I found the tooth material on the right maxillary side was shorter than that on the left by 2 mm., which caused the medial line of the maxillary teeth to carry that distance to the right under this treatment, and interfered with normal mesiodistal locking of the left molars.

I am showing this result not as a finished orthodontic transaction, but to demonstrate the possibility of predetermining tooth movement in this class of case, with the application of a definite amount of spring power

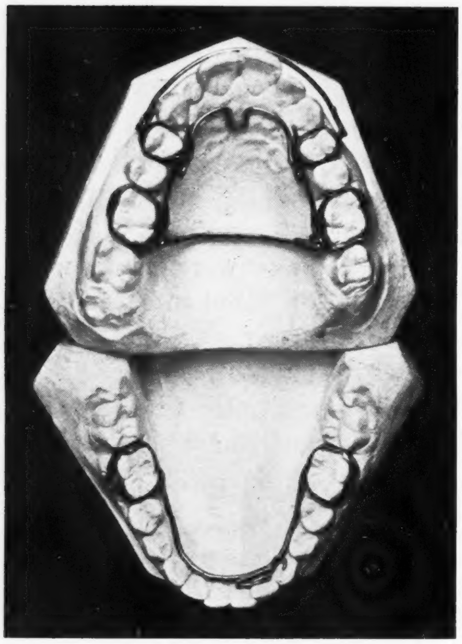


Fig. 9.

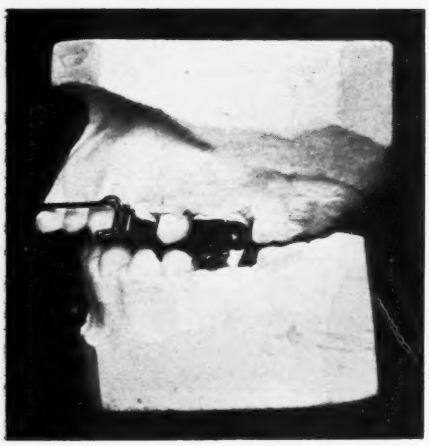


Fig. 10.

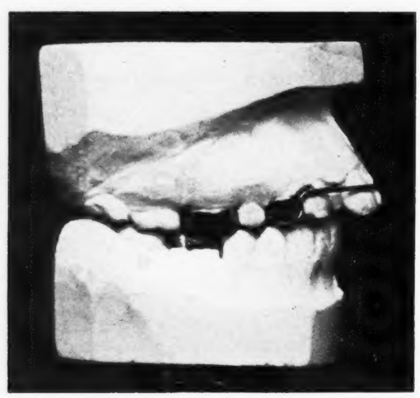


Fig. 11.

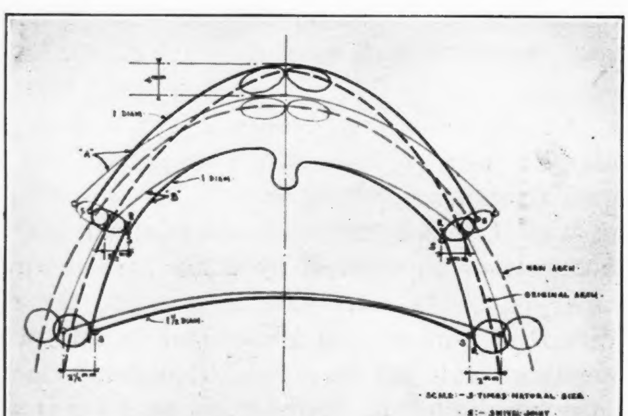


Fig. 12.

which would vary according to the gauge and length of the arch. Experience in this case and others has demonstrated that the wire used for the power

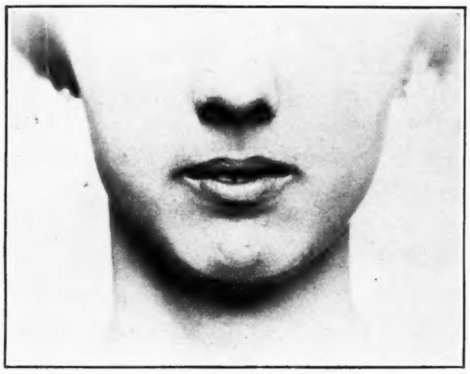


Fig. 13.

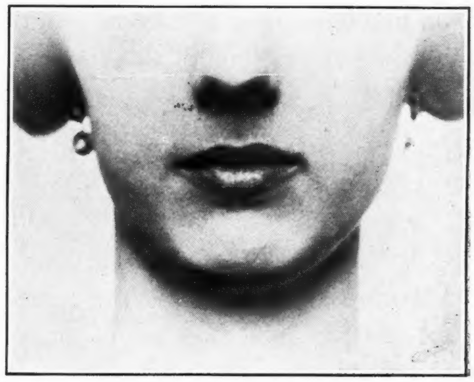


Fig. 14.

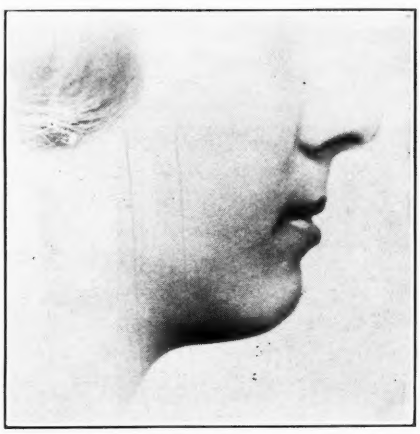


Fig. 15.

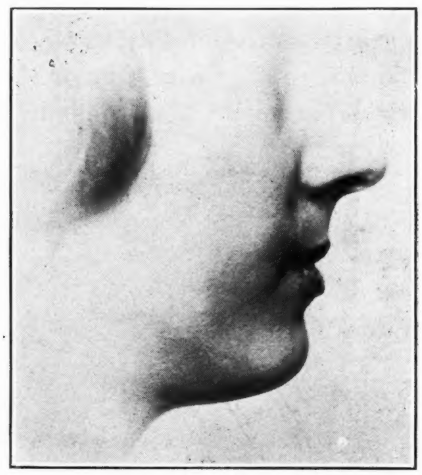


Fig. 16.

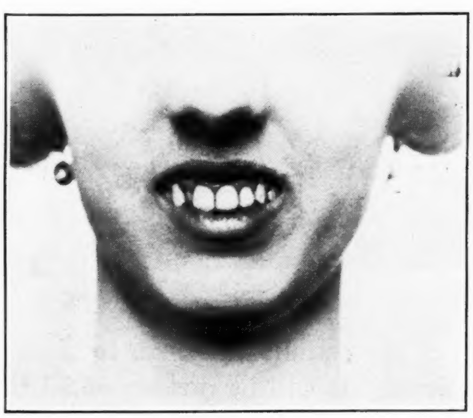


Fig. 17.

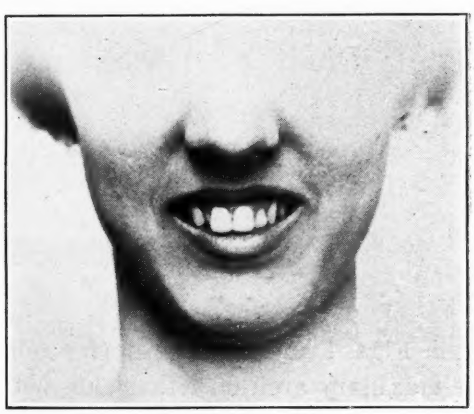


Fig. 18.

spring is best fitted for stable and safe application of force, as it is rigid enough to overcome ordinary oscillating action of the teeth in mastication.

I believe it is possible to reduce many forms of malocclusion by apply-

ing engineering principles and utilizing one application of force, thereby obtaining more beneficial results upon the osseous parts so treated. This method saves the patient as well as the operator, much time, and expands the limits of the orthodontist's ability in practice.

REPORT OF CASE*

By B. Frank Gray, D.D.S., San Francisco, Calif.

I AM sure those who see the figures illustrating this case will agree I am not presenting it because of completeness of result or to demonstrate any ideal orthodontic procedure. I am showing the work that has been accomplished in a particularly difficult and anomalous condition, thinking it might be of interest. Indeed if it may call forth some discussion and suggestions as to a better procedure, that would be of interest and of help to us all.

To add to the perplexity of the problem, the mandibular first permanent molars had been so seriously neglected that their remnants had to be removed.

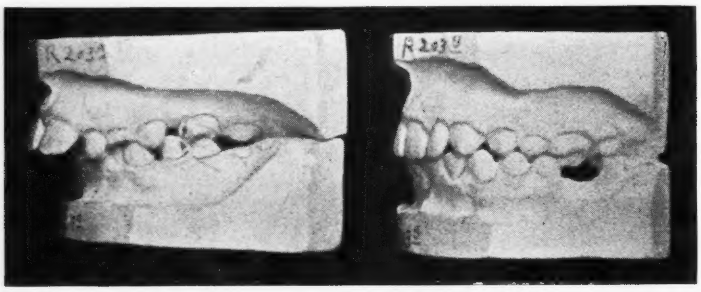


Fig. 1.

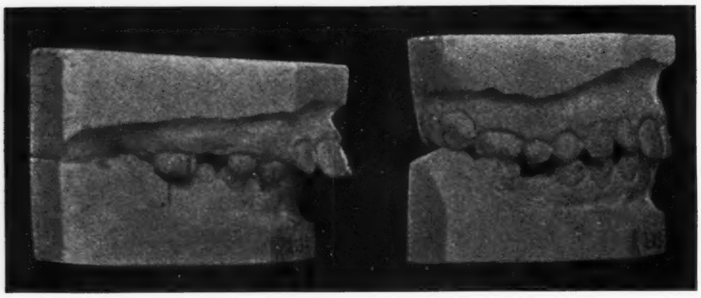


Fig. 2.

From Figs. 1 and 2 the posterior relation of the mandibular teeth to those of the maxillary arch on either side will be noted. It will be further noted that the mandibular teeth of the left side were allowed to remain in a posterior relation, and this inharmony continues around the arch and includes the premolar teeth of the right side. Although the mandibular right second molar

*Read before the American Society of Orthodontists, Kansas City, Mo., March 18-21, 1924.

Reprinted because of error in Figs. 3 and 4 in November issue.

has been made to occupy approximately the position of the first permanent molar, a space the width of the first permanent molar still remains. Some further adjustments are being made on the right side to improve the occlusion of the teeth.

The retention of the tooth in such a case is as difficult as the other fea-

Fig. 3.

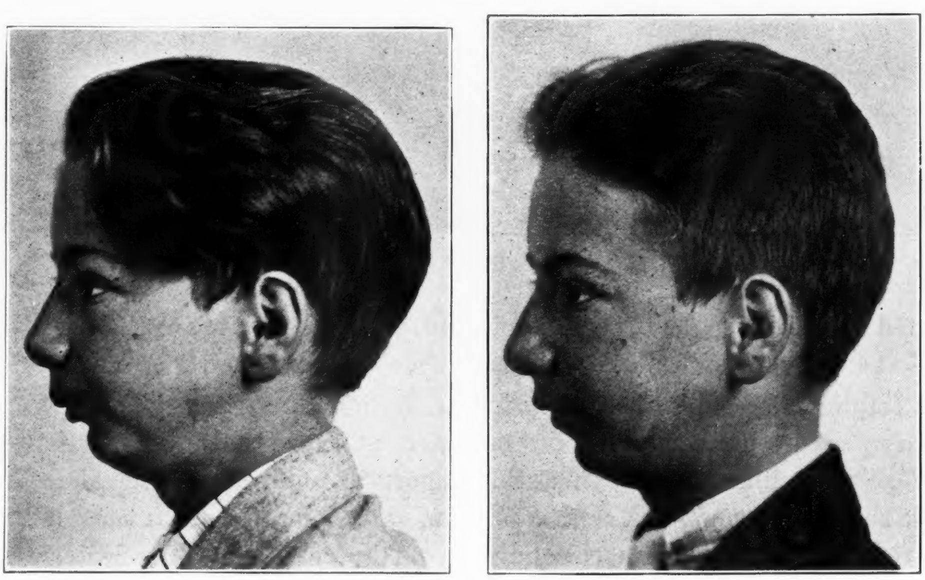


Fig. 4.

tures connected with this anomalous condition. In brief the patient is wearing a vulcanite plate in the mandibular arch, carrying substitute teeth for the extracted first permanent molars. This plate maintains the form of the arch, a matter of prime importance. It is expected a more hygienic prosthetic piece may be substituted for the vulcanite later on.

The maxillary arch is also maintained by a "Hawley Retaining Plate." In due time it is believed this may be dispensed with, depending wholly upon maintaining the harmonious contour of the mandibular arch for the retention of the two dentures.

The photographs of this lad, made at fourteen years of age and again at seventeen, present an unusual facial distortion. You may agree that some improvement has been secured, but it is not so marked as we would like. It was obvious at the outset that the facial inharmony was due in part only to malocclusion of the teeth. An examination by a well-known orthopedic surgeon, supported by radiographic examination, secured the following diagnosis: "Absence of the articular process of the left lower mandible. Neither Doctor ——— nor myself could say whether this was due to disease or to injury or was simply a congenital defect. Nothing, it seems to me, should be attempted surgically" The father of the lad, who is a physician, has been quite unable to account for this condition with any accurate information.

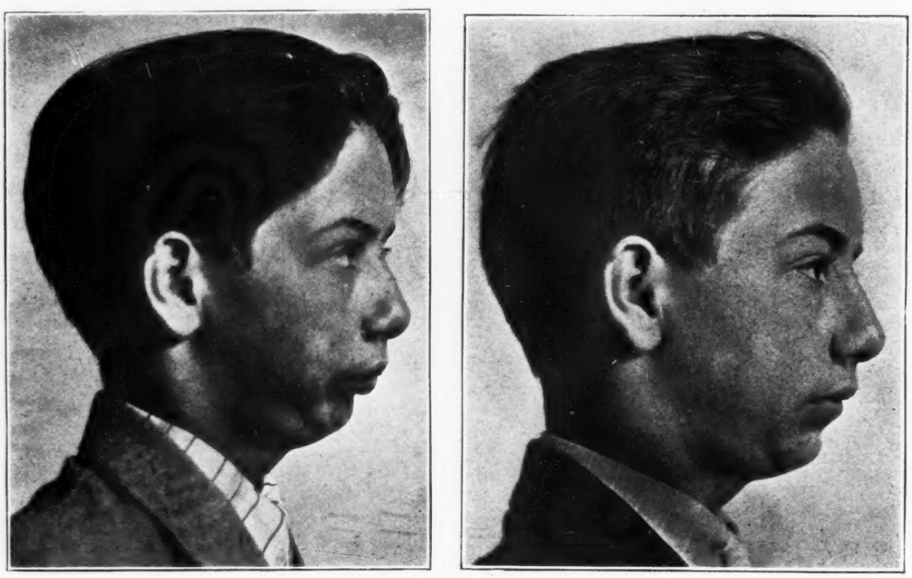


Fig. 5.

Complicated by his distant residence from San Francisco, I am unable to show creditable radiographic evidence at this time, but I shall include suitable illustrations when this report is published. The slide from which Fig. 6 was made met with a mishap, as will be noted. It may indicate in a poor way, an anomalous condition of the condyle of the left side, as stated by the orthopedic surgeon quoted above. The one unfortunate thing I believe, however, is the fact that unsatisfactory radiographic pictures were secured in the first place, indicating the unwisdom of depending upon even the best radiographic laboratories. In this instance the original examination was made by or under the direction of a famous radiographer, but the results were certainly most questionable. I have learned that even though the temporomandibular region is a difficult location to radiograph, I shall be

able myself to present good illustrations as stated, when this report is published.

In conclusion, it appears the anomalous condition of the articular process as noted may account for a shifting of the whole body of the mandible toward the left, thus accounting for the seriously defective aspect of the

Fig. 6.

face on the right side. Granting that we may be able to maintain the contour of the dental arches, it would appear the best additional hope this young man may have for future comeliness will be the cultivation of a vigorous and well trained beard.

DEPARTMENT OF

DENTAL AND ORAL RADIOGRAPHY

Edited By
Clarence O. Simpson, M.D., D.D.S., F.A.C.D.,
and Howard R. Raper, D.D.S., F.A.C.D.

A NEW KIND OF X-RAY EXAMINATION FOR PREVENTIVE DENTISTRY*

By Howard R. Raper, D.D.S., F.A.C.D., Albuquerque, N. Mex.

I

Introductory

THERE is no satisfactory solution to the pulpless tooth problem—except by the prevention of the pulpless tooth.

Dr. Mayo is quoted as saying that "dentistry can extend human life ten years."

How?

In one way only can dentistry do this. In no other way is it at present possible. That way is to prevent the pulpless tooth.

Dentistry is confronted with only one genuinely big problem today: prevention of the pulpless tooth. All other matters are trifling details compared to this.

II

Death and Disease

I ask you for the moment, to consider death and disease in a broad general way. When a man dies of disease (or old age) he does not die all over, all at once, click, just like that. He dies in pieces. Before his, I might say, final death, he is already dead and undergoing disintegration in parts (in the various organs) of his body. A very old or very sick person is already partly dead while the remainder of the organism awaits its turn.

Perhaps the most common and most noteworthy characteristic of disease is tissue death and destruction. Tuberculosis attacks and destroys the lungs; syphilis attacks the shin bone, the palate, the spinal cord; smallpox attacks the skin; gastric ulcer, the lining membrane of the stomach; destruc-

tive tissue change occurs wherever there is suppuration and, to a lesser degree, wherever there is inflammation; and so on. When we find albumin, casts, cells and blood in the urine, what does it indicate? Nephritis. Yes, but nephritis is only a name. The important thing about such urinary findings is that they represent destructive tissue changes in that vital organ of the body called the kidney. The loss of body weight, so common to all disease, is but another manifestation of the fundamental fact that disease spells tissue destruction.

The disease *dental caries* attacks the hardest structure in the body, the enamel of the teeth, and destroys it just as a cancer may destroy the soft tissues of the nose.

Thinking of disease, then, as a local death and disintegration of tissue which, if unchecked, leads to death of so much tissue that the organism as a whole dies, let us note the progress of dental disease.

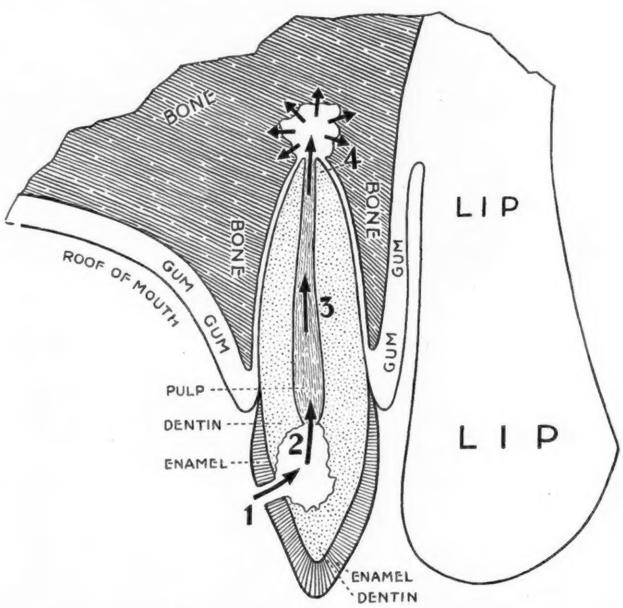


Fig. 1.—A schematic drawing illustrating the progress of dental disease (Characterized by the destruction of tissue) from simple dental caries to bone destruction and on into the general system. First, dental caries penetrates the armour of protective enamel, Arrow *1*. Thence, through the dentine, and into the pulp, Arrow *2*. On through the pulp Arrow *3* and through the tooth, out into the bone, Arrow *4*. And from there, to all parts of the body as suggested diagrammatically by the "burst" of six little arrows.

It has an auspicious beginning, attacking and destroying, as I have said, first, the hardest substance in the body, the enamel, and then it immediately attacks the next hardest tissue, the dentine.

If unchecked, this destructive activity, this death-process, next attacks the pulp and destroys it.

Then it passes through the tooth out into the bone, and destroys bone. Always the same: this disease, this *something* I have called the death-process, always the same in that it is progressive death and destruction of vital tissue.

From the bone it spreads to any part of the body: to the kidney causing nephritis, to the stomach causing gastric ulcer, to the joints, to the heart,

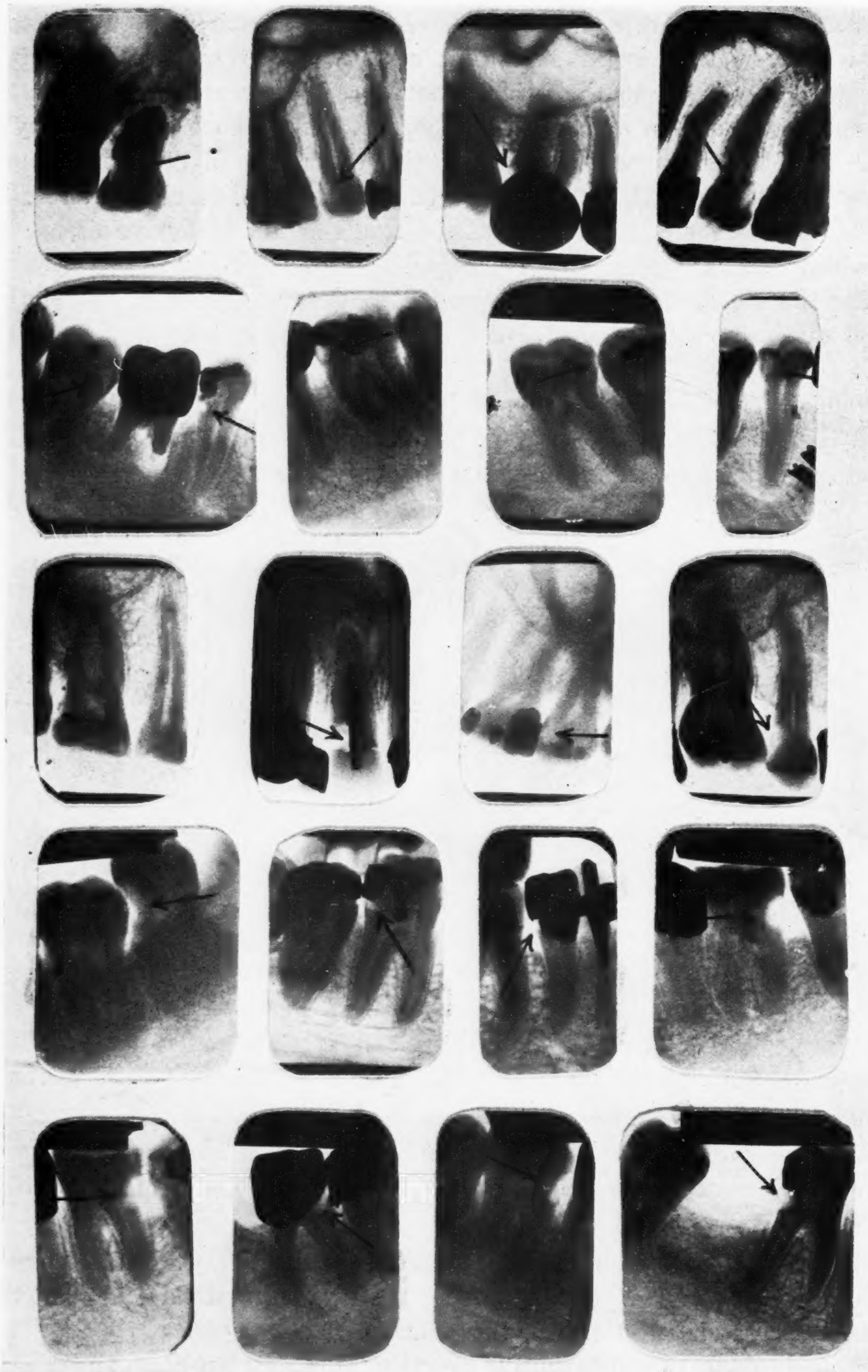


Fig. 2-*A*.—The arrows point to carious cavities revealed by the radiogram. The histories of many of these cases are interesting and illuminating. Take the first radiogram, in the second row of Fig. 2-*B* for example: The patient had been assured, after instrumental examination, that she did not have a cavity in this molar, though she insisted she had. The radiogram next to this one—i.e., the second one in row two, Fig. 2-*B*—is of a patient who went from one man to another seeking relief from pain. The cavity was not found until the patient fell into the hands of an exodontist who made a radiogram: In this case the caries penetrates the enamel through a very small opening and destroys a great deal of dentine, the common thing for caries to do but exaggerated in this case. In Fig. 2-*C*, top row, second radiogram, we see a case where the failure to find a cavity at the cervical of a proximo-occlusal restoration cost the patient a tooth. And so on..............

Several years ago I reported a case* in which the patient complained of toothache,

*"Elementary and Dental Radiography."

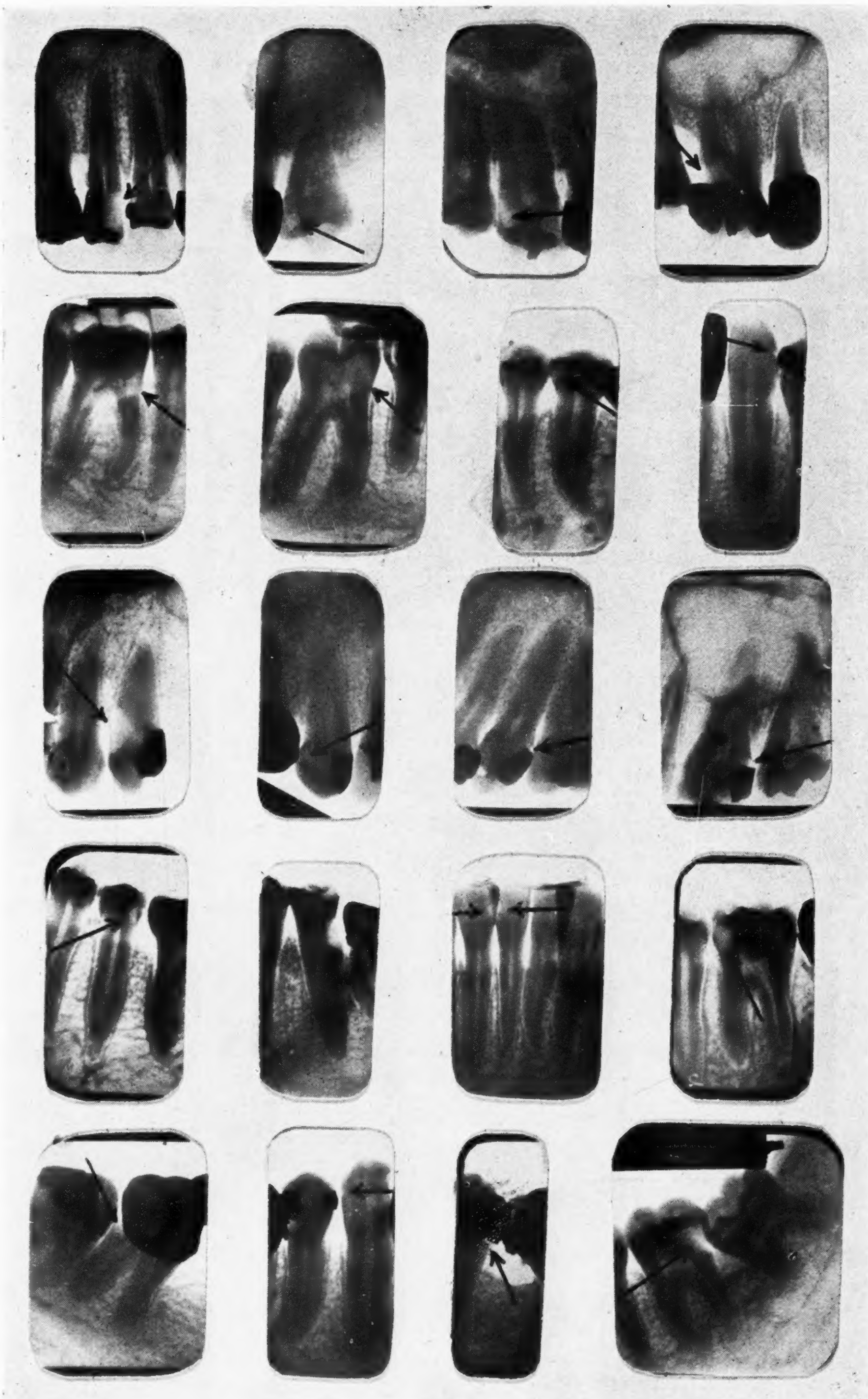


Fig. 2-*B*.—Continuation of Fig. 2-*A*.

visited several dentists who told him that his teeth were all right and that he had neuralgia, went on an alcoholic spree and wound up in a hospital as a result of the alcohol debauch. At the hospital, when he had recovered somewhat from alcoholism, the patient again declared he had toothache. A dentist was called. He failed to find anything wrong with the teeth by ocular instrumental examination, but advised the making of a radiogram. The radiogram revealed a hidden carious cavity. To those who will say the cavity should have been found by instrumentation I reply simply that it wasn't. This all happened several years ago when very few dental radiograms were being made. It probably could not happen today. A patient would not get far with pain in the teeth before a radiogram would be made.

Fig. 2-*C*.—Continuation of Fig. 2-*B*.

to the eye, almost anywhere. It seems probable that even the carrier itself, the blood, may be attacked, causing erythropenia and other degenerative changes.

What I am saying is, of course, not new. But the way I present it is perhaps individualistic, and I want you to look at it my way for the moment. I want you to get the idea of the death-process as a moving thing, entering the tooth, going through it and so into the bone and the body. (Fig. 1.)

It is our duty as dentists to keep this death-process out of the body. How?

Once it has gone as far as to destroy the pulp, or farther, can we always stop it *with certainty;* keep it from reaching the vital organs? *We cannot,* not with *certainty.*

Can we keep it from starting at all by preventing dental caries? Again *we cannot.* Not today. Perhaps, tomorrow. But not now.

Can we stop it when it is in the stage of dental caries, before pulp involvement? WE CAN.

Then, in the name of common sense and for the sake of humanity, why don't we?

I believe we will in the future.

III

Radiographic Interproximal Examinations

A great enterprise usually hangs on a certain peg, if you know what I mean. For example, the recent clean-up of septic mouths in America hung on the peg of the general x-ray examination.

The future preventive dentistry will, I believe, also hang on an x-ray peg. It is that peg that I wish to show you and describe to you here; it is an interproximal examination made radiographically. Of course time only will tell whether this new kind of a radiographic examination of the mouth really has the revolutionary importance I think it has.

IV

The Need of Radiographic Interproximal Examinations

Dentists do not always find interproximal cavities. To substantiate this statement I submit Figs. 2-*A*, 2-*B* and 2-*C*. This illustration shows numerous (sixty odd) proximal carious cavities revealed by the x-rays. Such x-ray findings are very common indeed. I could show literally thousands of such cases, if it were necessary to prove my point. However I take it that the point is one which will not be much questioned. Wherever there is a file of dental x-ray negatives it will be found on examination to contain hundreds, or thousands (depending on the size of the file), of cases where unsuspected, or at least unlocated, carious cavities have been found by means of radiograms.

Another way to become promptly and deeply impressed with the fact that a great proportion of proximal cavities are not found by ordinary instrumental examination is to notice, day by day in your practice, if you are

a radiodontist, the very great number of such cavities revealed, which were not suspected by either dentist or patient.

Stop to consider this: In a mouth with all the teeth in place, there are 60 interproximal surfaces! Imagine making a *thorough* instrumental and ocular examination of all these surfaces! If the operator took thirty seconds to a surface it would take him thirty minutes to make the examination, and if he took one minute to a surface it would take an hour; *and even then he could not be sure that he had not overlooked cavities.* How many men take even as long as say fifteen minutes to examine the proximal surfaces of the teeth for decay? Not many, I believe.

As dentistry is practiced today, the fact is that we do not find proximal cavities until they are quite large, and, if they are deep seated—i.e., way under the gum—we seldom find them until the patient "complains" and then it may be too late, the pulp may be involved.

In cases of proximo-occlusal fillings it is especially difficult to tell when caries is recurring at the cervical margin, except by the use of the radiogram.

"It feels like I have a cavity in between those teeth, Doctor." When patients say that to a dentist, as they frequently do, the dentist often takes as long as ten minutes or longer to examine that particular region, instrumentally. And when he is through, if he has failed to locate a cavity, there is still a feeling of uneasiness and uncertainty.

There are men who claim to be able to find all proximal cavities, but these wizards are, I believe, destined to become extinct, along with the miracle men who used to claim they filled all canals to the end.

Even assuming for the sake of discussion that it is *possible* to find all proximal cavities by instrumentation, still the fact remains that they *are not* found. Furthermore the old practice of separating teeth to examine for proximal decay is far inferior to the radiographic method; it is slower, sometimes painful and less reliable—altogether less satisfactory and less practical.

And how does the operator know when teeth should be separated to examine for proximal decay? Ordinarily he waits until the patient complains or until the enamel is so undermined that it changes appearance on the occlusal surface. To wait this long endangers to a variable degree the life of the pulp, the thing we want to avoid.

Exposures for a complete five-film interproximal examination can be made in the time or even less time than it often takes to separate two teeth and examine the two proximal surfaces. (Exposures for a complete set of five interproximal negatives can be made in five or ten minutes.)

V

The Nature of the Radiographic Interproximal Examination

It has been known for a long time that the x-ray examination can be depended upon to locate proximal decay, even in a most incipient stage. But, for some reason or combination of reasons, it has been little used for the

Fig. 3.—Other lesions besides dental caries may also be revealed by the interproximal examination. Such lesions, for example, as: Pyorrhea (*A*, *B*, *C*). Bone destruction due to ill-fitting crowns and overhanging fillings (*D*, *E*). Perforations (*F*, *G*). Supernumerary teeth (*H*). Unerupted third molars (*I*, *J*), and others not illustrated here but mentioned in the text. Incidentally, *C*, *G*, *H*, *I* and *J* show carious cavities. In *C*, the mesial of the cuspid; *G*, the distal of the second molar; *H*, the distal of the left central incisor; *I*, distal of the second molar; *J*, distal of the second molar. Radiogram *A* shows calculus on the distal of the second molar and mesial of the third.

Radiograms *H* and *C* are of the same cases as Figs. 8 and 9 respectively. See Figs. 8 and 9 (or Fig. 4-*B*, 5-*B* and others) and the reader will realize that these lesions illustrated here in ordinary radiograms would be revealed in interproximal examination negatives made as herein described.

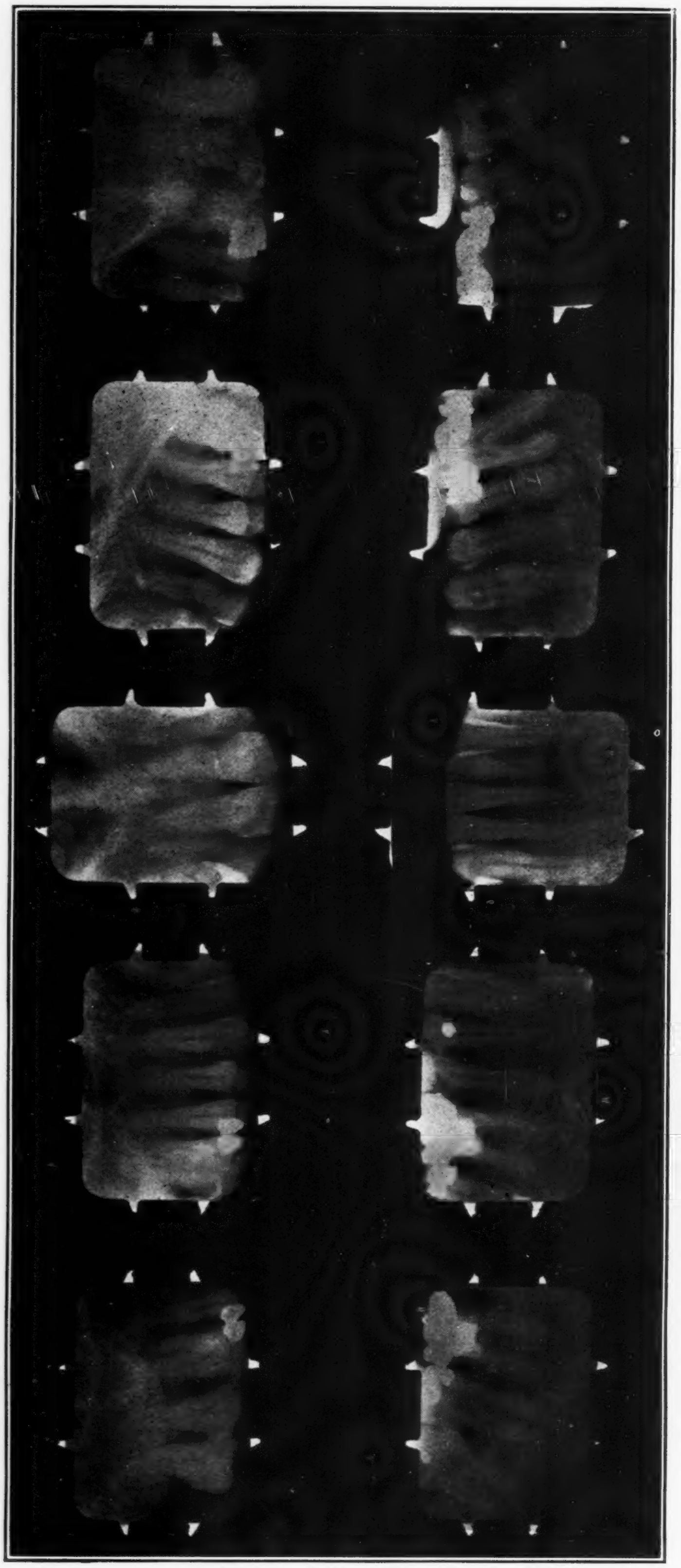


Fig. 4-*A*.—The ten-film general examination. ("Radiodontia.")

Fig. 4-*B*.—The new five-film interproximal examination.

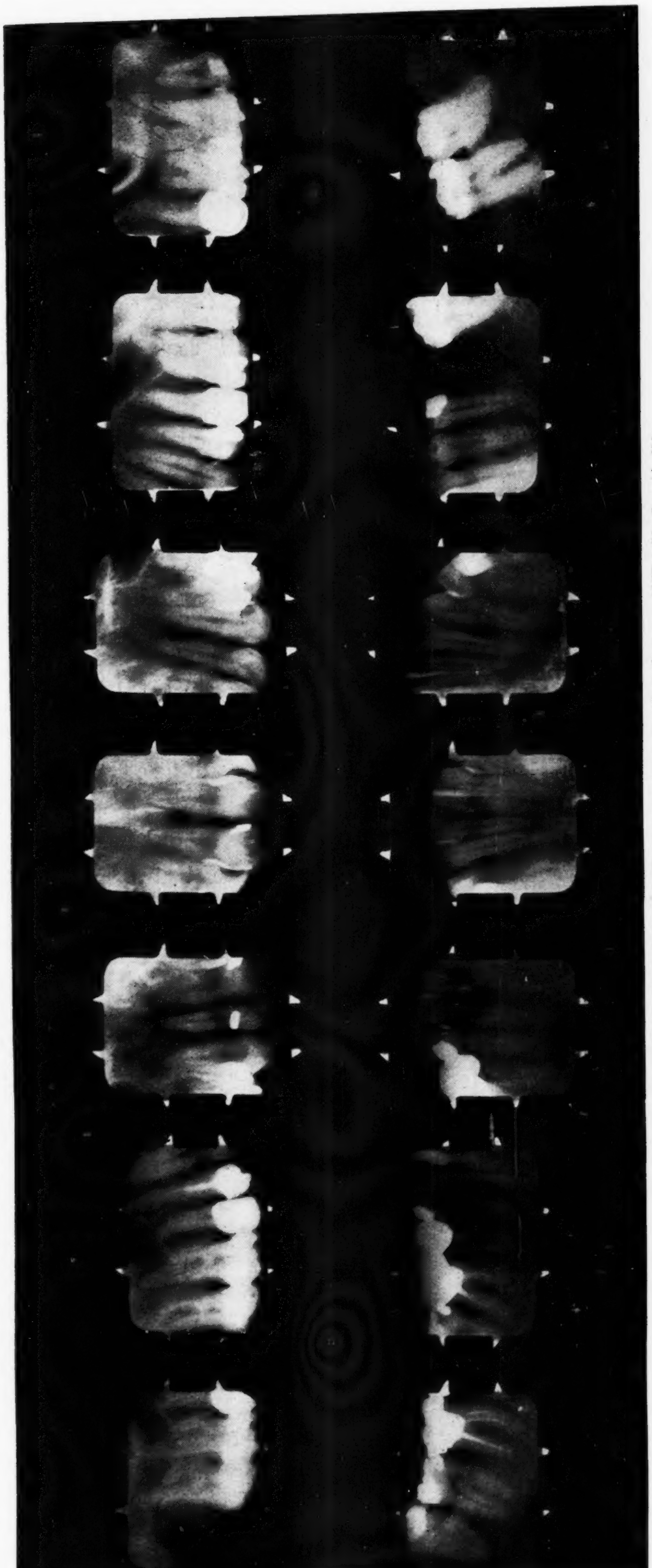


Fig. 5-A.—The fourteen-film general examination. ("Radiodontia")

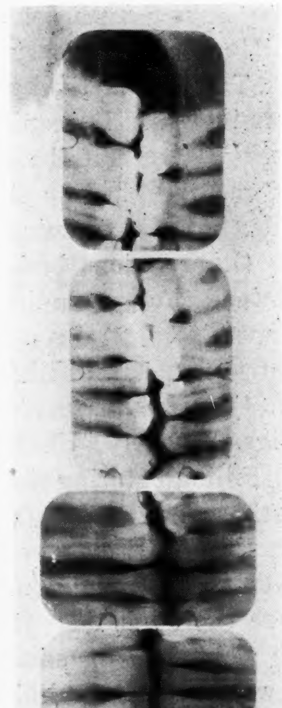


Fig. 5-B.—The new seven-film interproximal examination.

purpose. Perhaps the amount of work and the consequent expense has been the deterring factor; it has doubtless been an influence.

Ordinarily it requires 10 or 14 negatives (depending on the degree of thoroughness) to make an x-ray examination of the mouth. Such examinations include the root ends.

It is not necessary to include the root ends to examine for dental caries.

The new method herein recommended and described is an interproximal examination. It requires just half the usual number of negatives, half the work and so half the expense, because both maxillary and mandibular teeth are radiographed on the same negative. Occasionally one "gets" some root ends, but the examination is essentially an interproximal examination.

Other lesions besides caries may be located by the interproximal examination. For examples: (1) Calculus and incipient pyorrhetic osteoclasia (Fig. 3-*A*). (2) Deep isolated pyorrhea pockets (Figs. 3-*B* and*C*). (3) Bone destruction due to ill-fitting crowns and overhanging fillings (Figs. 3-*D* and *E*).(4) Radicular perforations (Figs. 3-*F* and *G*). .(5) Supernumerary teeth (Figs. 3-*H*). (6) Unerupted third molars (Figs. 3-*I* and *J*). (7) Pulp stones. (8) Filling entering the pulp chamber (Fig. 11-*A*). (9) Pieces of gum-covered tooth roots. (10) Succedaneous teeth.

Fig. 4-*B* illustrates the five-film interproximal examination, Fig. 5-*B* the seven-film examination. The fourteen-film general mouth examination is far more thorough than the ten-film examination. But I rather doubt whether the seven-film examination is equally superior to the five-film examination. It will take more clinical experience to know. It is a fact worth recording here that the five-film interproximal examination is a better examination of the coronal half of teeth and contiguous parts, than the ten-film general examination. This, because the angles for the five-film examination are better for an examination of the interproximal regions than the angles used for the ten-film examination.

The primary survey will not always show the conscientious operator all he wants to see even when it is a survey of 14 films or more. He may wish to have another look at a certain selected region or regions. Naturally this is true of the five- and seven-film interproximal examinations also.

(*To be continued.*)

DEPARTMENT OF
ORAL SURGERY AND SURGICAL ORTHODONTIA

CONTROL OF POSTOPERATIVE DENTAL PAIN*

By Robert Friedman, D.D.S., New York

THE experience of every dental practitioner indicates that postoperative pain is an important surgical factor, and of course largely depends upon the area involved. The anatomic and pathologic complications found in the mouth are quite extensive, and in addition thereto presents one of the most intricate nervous mechanisms in its relation to the fifth cranial nerve.

Postoperative dental pain may be due to—(1) a nonisotonic solution; (2) adrenalin in the solution; (3) trauma; (4) surgical interference; (5) marked tissue destruction; (6) acute inflammatory conditions; (7) infection.

An isotonic solution is a solution consisting of distilled water and sodium chloride to the extent of 0.85 per cent. This is known as a physiologic saline solution, and is isotonic because it contains the same amount of sodium chloride as the blood. If a solution is injected into the tissues that does not correspond with this percentage, we have either a hypotonic or hypertonic solution. In either case the cells absorb the solution and become changed in form and character in proportion to the amount of sodium chloride. When an adjustment takes place, the altered cells either take in more salt from the blood stream, or else cast off the excessive amount. In so doing the cells change in their size and form, which alteration manifests itself by pain. Obviously then, only isotonic solutions should be injected into the tissues.

Adrenalin, or suprarenal extract is added to the novocaine solution, primarily to contract the blood vessels in the area of the injection so that the novocaine may be effective for the longest possible time. The effect of contraction is, that in the injected area there is a temporary state of anemia, whereas in the immediately contiguous area, the circulation is abnormal—due to the surrounding vasoconstriction. As the effects of the anesthesia and adrenalin wear off the circulation begins to readjust itself. As this readjustment takes place there again occurs an admixture of blood, and a reciprocal

*Dental Surgeon, St. Luke's Hospital, New York City.

replacement of oxygen and carbon dioxide which also causes pain. However this pain is localized and of short duration.

Surgical interference, traumatic conditions, and marked tissue destruction therefore, are the most important outstanding causes for postoperative pain, and radical surgery in the mouth presupposes trauma and tissue destruction. Trauma is due to excessive chiseling and cutting with various surgical instruments, such as burrs and trephines, or excessive pressure from forceps or elevators. To overcome pain from this source it is advisable to chisel sparingly and with the least amount of force necessary, to resort to surgical burrs as little as possible, and never to use excessive force in extractions, either with forceps or elevators. Where surgery is indicated, it must be performed with these admonitions constantly in mind so as to have the minimum amount of after-pain.

In acute inflammations, we have reactions of the tissues to an irritant and the liberation of bacteria confined in the tissues. The only way that we can control these factors is by the use of ice cold applications. The cold prevents too great an influx of blood into the tissues and reduces the heat necessary for the growth of bacteria.

When the pain is marked it becomes necessary to control it with drugs given internally. Usually a sedative is administered. Should this fail to bring the desired relief an anodyne or hypnotic is indicated. Until a comparatively recent time it was necessary to resort to bromides or morphine. This is no longer necessary owing to a newly discovered drug which when given in increasing doses acts first as a sedative, then as an anodyne, and finally as an hypnotic without narcosis or any of the other disadvantages of morphine. This drug is allonal, a nonnarcotic nonhabit-forming drug with strong analgesic power. To date I have administered it in a large number of cases with very fine results and with no apprehension that it will create a habit or addiction.

Allonal is prepared in tablets containing two and two-third grains each. For a sedative action one tablet is administered, for an anodyne or hypnotic action from two to four tablets are given. I have never yet had to order more than two tablets for each dose to obtain the desired action. It gives quick relief from pain. After the administration of the drug it has been my custom to prescribe a laxative.

In addition to the numerous fields of medicine in which it has been employed, embracing almost all of the specialties, the following valuable papers on its use have been contributed by the dental profession: "The Refractory Dental Patient," by T. J. Bartley and A. B. Leavitt, in *The Dental Cosmos,* March, 1923; "Combined Dental Anesthesia and Analgesia," by J. Frankel, in *The Dental Cosmos,* November, 1923; "The Control of Pain," by C. H. Dodge in *Dental Facts,* January, 1924; and "Pre-Operative and Post-Operative Dental Analgesia," by B. Kornfeld in *The Dental Cosmos,* April, 1924.

That the analgesic action of this new drug is satisfactory, even in conditions of the severest pain, has been already well demonstrated by the reports in medical literature; I began to use it in oral surgery immediately after the announcement of its value in medicine was made in the first article by M. A.

Burns of Philadelphia and during two years' wide use of it have found its action consistently good—at times almost remarkable in the direction of relief of pain as is evidenced in the following case reports, which are typical of many in which it has proved of great service.

CASE 1. Mr. L. S., forty-five years; referred with large swelling at the right angle of mandible extending down into the pharynx, caused by roots left remaining after an attempted extraction. Patient had temperature of 103.5° F. and pain of excruciating character, which with the pathologic condition had caused a loss of twenty-five pounds weight in one week. One allonal tablet gave almost immediate relief from pain and another at night lent its aid to natural sleep; administered one tablet at a dose it was used in this case for a period of over three weeks without any undesirable after-effects.

CASE 2. Miss G. M., twenty years; referred with impacted maxillary left third molar which was causing extreme suffering. Half an hour before removal of the tooth one allonal tablet was administered; it almost immediately caused inhibition of the sensory irritation; after the operation one tablet to a dose was administered and caused sleep within ten minutes.

CASE 3. Mr. J. H. O., forty-two years; referred with mandibular left partially impacted third molar having peri-coronal infection which had penetrated into the cortical section of the ramus causing necrosis, involving removal of the ramus and the coronoid process attached thereto. During the removal of this necrotic bone considerable dissection of the soft tissue and muscular attachments was essential. This surgical work was done without the administration of a general anesthetic and the pain caused was almost unbearable; relief was soon affected by the administration of two allonal tablets and maintained thereafter by one tablet every three hours. Allonal was used intermittently as required in this case for a period of ten weeks, one tablet at a time, with absolute certainty of action.

In these cases and in many others of similar severity I feel that I would have had to administer morphine as the supreme hypnotic but for the use of this comparatively new and very valuable nonnarcotic drug, allonal.

ABSTRACT OF
CURRENT LITERATURE

Covering Such Subjects as

ORTHODONTIA — ORAL SURGERY — SURGICAL ORTHODONTIA — DENTAL RADIOGRAPHY

It is the purpose of this JOURNAL to review so far as possible the most important literature as it appears in English and Foreign periodicals and to present it in abstract form. Authors are requested to send abstracts or reprints of their papers to the publishers.

Diet and Nutrition with Reference to the Teeth. T. B. Hartzell (Minneapolis). The Dental Cosmos, November, 1924, lxvi, 1198.

From a long address on this subject we select the following as of particular interest. The author recently examined the teeth of forty inmates of a St. Paul orphanage who have been under the constant supervision of a dentist connected with the Research Commission. Upon admission a number of these inmates had teeth in poor condition but very little caries developed after admission to the institution. The age limits are two and one-half to sixteen years, covering almost the entire period of childhood. Some, it is true, have been inmates for but a short time, so that the dietetic factor cannot be overemphasized. The food, however, is certainly worthy of consideration as a possible factor in the arrest of caries, in association with regular scaling and cleanliness of the teeth and personal hygiene in general. The menus are somewhat as follows: evening meal, whole wheat or rye bread, white bread and butter; apple sauce, an orange, glass of milk, plain white cake. The noon meal comprised baked fish or roast beef; cabbage salad, potatoes, parsnips, baked squash, white bread, cornstarch pudding, milk, and candy. The morning meal is taken from the following dishes: white bread, whole wheat bread; cereal consisting of a mixture of oats, wheat and rye; stewed prunes, jelly bread, milk. These appear to be only sample meals so that still more variety is possible. In theory such a diet could be accused of an excess of carbohydrates but any possible disadvantage is clearly compensated as shown by the results. The author is quite sure that under a monotonous diet of white bread, pork fat, sugar and coffee—which obtained in one locality studied—cleanliness and hygiene alone could not have arrested the high degree of caries found.

The Buccal Cavity in Wind Instrument Players. E. Reichenbach (Munich). Zeitschrift fur Stomatologie, 1924, xxii, no. 9.

The author is attached to an orthodontic clinic of the dental department of the University and thus speaks with authority in connection with an intensive study of the mouth cavity in wind instrument players of every variety.

His conclusions are in part as follows: the cavity and especially the teeth show alterations directly attributable to the patients' occupations. There are anomalies in the structure of the teeth and in the alignment of the same. It has long been known that certain defects in the teeth tend to prevent playing and practicing on these instruments. It should be insisted on therefore in all music schools that the mouths of prospective pupils be examined before they choose their careers. If gaps and other defects be present in the teeth it may of course be possible to correct them by proper orthodontia. The various pathologic consequences of blowing wind instruments may be minimized by dental supervision and treatment.

The manner in which this kind of occupation can cause pathologic consequences is threefold. First, the factor of leverage of the mouthpiece. Second, the slight displacement of the articulations which results from blowing and third, the increase of air pressure which results from the same cause.

The author considers in detail a number of instruments from the large horns down to the fife. Players of brass instruments, irrespective of size, present far more pathology than those who blow wood instruments. The mouthpiece is also a marked factor in producing anomalies, and instruments with no mouthpiece (flute) apparently gave no trouble at all. The peculiar mouthpiece of the oboe and bass horn is also nearly free from mischief.

The International Journal of Orthodontia, Oral Surgery and Radiography

PUBLISHED THE FIFTEENTH OF EVERY MONTH BY

THE C. V. MOSBY CO., 801-809 Metropolitan Bldg., St. Louis, Mo.

Foreign Depots—*Great Britain*—Henry Kimpton, 263 High Holborn, London, W. C.; *Australasia*—Stirling & Co., 317 Collins Street, Modern Chambers, Melbourne; *India*—"Practical Medicine," Egerton Street, Delhi; *Porto Rico*—Pedro C. Timothee, Rafael Cordero 68, San Juan, P. R.

Subscription Rates.—Single copies, 75 cents. To anywhere in United States, Cuba, Porto Rico, Canal Zone, Mexico, Hawaii and Philippine Islands, $6.00 per year in advance. Under foreign postage, $6.40. Volume begins with January and ends with December of each year.

Remittances—Remittances for subscriptions should be made by check, draft, postoffice or express money order, or registered letter payable to the publishers, The C. V. Mosby Company.

Contributions—The editor will be pleased to consider the publication of original communications of merit on orthodontic and allied subjects, which must be contributed solely to this journal.

Opinions—Neither the editor nor the publisher hold themselves responsible for the opinions of contributors, nor are they responsible for other than editorial statements.

Reprints—The publishers will communicate with authors regarding reprints upon publication of paper.

Communications—Contributed articles, illustrations, letters, books for review, and all other matter pertaining to the editorial department should be addressed to the Editor, Doctor Martin Dewey, 501 Fifth Ave., New York City. All communications in regard to advertising, subscriptions, change of address, etc., should be addressed to the publishers, The C. V. Mosby Company, 801-809 Metropolitan Building, St. Louis, Mo.

Illustrations—Such halftones and zinc etchings as in the judgment of the editor are necessary to illustrate articles will be furnished when photographs or drawings are supplied by the authors of said articles.

Advertisements—Objectionable advertisements will not be accepted for publication in this Journal. Forms close first of month preceding date of issue. Advertising rates and sizes on application.

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Entered at the Post Office at St. Louis, Mo., as Second-Class Matter.

EDITORIALS

Our Tenth Anniversary

To the cynic, the commemoration of anniversaries is inane sentimentality. We are thankful not to be actuated by a cynicism which has never made the world better or lives happier. Aside from sentiment and pride in achievement, the record of the International Journal of Orthodontia, Oral Surgery and Radiography is worthy of thoughtful consideration and formal comment. By historic comparison, ten years is a brief period, yet tremendous evolutions occur in shorter spans.

Ten years ago orthodontia, one of the first established specialties of dentistry, was in the throes of empiricism. Its leaders were antagonistic champions of arbitrary methods which obscured principles. Some of the expounders of theories were, through the perception of genius, in advance of their

time, but they had not deduced the fundamentals for logical demonstration and precise application. The science of orthodontics is not yet stabilized, but it is rapidly developing along rational lines.

The policy of the American Society of Orthodontists in gathering from collateral sciences information which clarifies orthodontic problems, indicates an earnest desire for knowledge. The programs of the Society in recent years have been rich in contributions from other specialties and professions, and this influence is evident in the broader conception of orthodontics which prevails.

A profession or specialty is judged by the character and volume of its literature. Original articles on technical subjects require intensive study, which improves the writers and increases the store of recorded knowledge. During the past decade the International Journal of Orthodontia, Oral Surgery and Radiography has published more than 9000 pages of text with over 4000 illustrations on orthodontics and allied subjects. No other specialty of dentistry, medicine or surgery has equalled this record of current literary production. The extensive scope presented for investigation, and the progressive spirit of orthodontists insures a consistent annual supply of valuable new material.

To encourage the development of two other important specialties by a restricted organ of publication, the departments of Oral Surgery and Oral Radiography were established. The response by articles contributed and the wide circulation among men who do not practice orthodontia has been a gratifying testimonial of appreciation. Radiography is indispensable to every branch of dental practice; oral radiography has not been given the deserved attention, and we believe a distinct service has been rendered in issuing instructive articles on this subject each month.

It is a privilege to serve the profession with a medium of publication, and to promote the interests and advancement of specialization. A periodical devoted to a limited field of dentistry was an innovation, but the reception and support accorded it has proved the practicability of the enterprise. For the success of this accomplishment the credit is due to the excellent cooperation of the editorial staff, the courtesy of the societies which have contributed their proceedings, the loyalty of our subscribers, and the generosity of our advertisers.

A Dental Chemistry and a Dental Formulary*

THESE two interesting and instructive books, though originating in widely separated universities, come to our desk together. While the subject matter in each is somewhat similar, there is wide divergence in the manner of their treatment. The work of Prof. Gibson is in a more scientific or rather technical style than the work of Prof. Prinz, who might be said to have gone over in his laboratory all of the chemical experiments necessary, and then

*The Chemistry of Dental Materials by C. S. Gibson, O.B.E., M.A., and B.S., (Oxon) M.S. Tech. (Manc.) F.I.C., 24 illustrations, $3.50. P. Blakiston's Son and Co., Phila.

Dental Formulary, Herman Prinz, A.M., D.D.S., M.D., third edition thoroughly revised. Lea and Febiger, Phil. and N. Y., $3.50.

handed to the profession a comprehensive and applicable series of formulæ, recipes, and prescriptions in such form as to be readily made use of by the busy dentist.

Prof. Gibson opens with a survey of the uses of various dental materials which he first divides into four groups, viz.—conservative materials, prosthetic materials, orthodontic materials, laboratory materials. These materials he then proceeds to describe and indicate the uses to which each may be put. Part I is devoted to metals and alloys, first giving the general properties of metals and then taking up one by one each of the metals which are used in dentistry, giving their properties, alloys, chemical combinations, etc. Part II is devoted to the Miscellaneous Materials used in dentistry and under different chapters is found reference to porcelain, plaster, abrasive materials, cements, anesthetics and antiseptics, rubber vulcanite, etc.

The author has endeavored to assist both student and practitioner in obtaining as complete a knowledge as possible of the properties of the materials which he is called upon to use in his daily work.

Prof. Prinz approaches his subject somewhat differently. He has, through his wide experience, taken the best combinations of drugs and chemicals, and after proving them, has presented to the profession his Formulary to which it can turn for advice not only in the preparation of mixtures of different medicaments, but he gives directions for the manipulation of plaster, waxes, etc., the making of alloys, electro-plating and coloring of gold, pharmaceutical compounds such as perfumes, soaps, hand lotions and other such preparations more or less useful but representing the many inquiries which were received from dental practitioners. An index to oral diseases and a section on immediate treatment of acute poisoning are also included. Several special articles by well-known authorities are a valuable addition. This book presents a mass of useful information and we welcome this the third edition with its recent improvements and advise its inclusion in every dentist's library.

Conduction and Infiltration Anesthesia*

THIS new work is put forward with the idea of presenting this subject rather for the undergraduate than for the more experienced operator.

A very concise and interesting chapter on "The Birth of Anesthesia" opens the book, emphasizing again that America gave anesthesia to the world.

The author lays great stress on the importance of a thorough knowledge of the anatomic structures encountered in nerve blocking, saying, "It is not sufficient to know only the approximate points of insertion and the direction of the needle. The trained anesthetist knows exactly the position and relation of the various structures through which his needle must pass to reach its proper point of destination." A chapter on the trifacial nerve presents this subject adequately both in the text and also by means of numerous illustrations.

A chapter on the technic of producing anesthesia of the maxillae is fully

*Conduction and Infiltration Anesthesia by Mendel Nevin, D.D.S., Dental Items of Interest Publishing Company, Brooklyn, New York. 190 illustrations. $5.00.

illustrated and the operation completely described; and also one describing pterygomandibular anesthesia, which chapters comprise the bulk of the work.

In speaking of extraoral injections, the author cites reasons for employing this technic and says, "Extraoral injections are not any more difficult than intraoral, and their technic may be mastered just as readily."

A chapter on infiltration anesthesia is fully explained and illustrated. The remaining chapters have to deal with pharmacology, preparations of solutions, instrumentarium, postoperative sequelae, postoperative pain and its treatment, toxicity, etc. The volume is concluded with a set of questions and answers.

The author should, however, endeavor to standardize his nomenclature; for instance, he writes "mandibular" and "inferior maxillary" indiscriminately. He uses the term "mandible" but usually speaks of the "superior maxillary." He writes about the "canine fossa" but says "cuspid tooth." The typography and engraving are to be highly commended. A large chart of the trifacial nerve showing its distribution is bound inside the cover of the book.

ORTHODONTIC NEWS AND NOTES

American Society of Orthodontists

The Twenty-fourth Annual Meeting of the American Society of Orthodontists will be held in the new Atlanta-Biltmore Hotel, at Atlanta, Ga., April 14, 15, 16 and 17, 1925. (Mark off the date now.)

Walter H. Ellis, Sec'y-Treas.,
397 Delaware Avenue,
Buffalo, N. Y.

Clinton C. Howard, President,
Doctors Building,
Atlanta, Ga.

New York Society of Orthodontists

The annual meeting of the New York Society of Orthodontists will be held on Wednesday afternoon and evening, March 11th, 1925, at the Hotel Vanderbilt, Park Ave. and 34th Street, New York, N. Y.—William C. Fisher, Secretary, 501 Fifth Ave., New York, N. Y.

The American Society of Dental Radiographers

The mid-winter meeting of the American Society of Dental Radiographers will be held in Chicago on Tuesday, January 20th. A program of unusual interest has been prepared. All dentists interested in radiography are invited to attend.—Martin Dewey, Secretary, 501 Fifth Ave., New York, N. Y.

Kentucky State Dental Association

The next annual meeting of the Kentucky Dental Association has been postponed from April 7th to 9th, 1925, to a business session September 11th to 12th, 1925.—W. M. Randall, Secretary, 1035 Second St., Louisville, Ky.

Notes of Interest

Dr. Ralph W. Eaton announces the removal of his office from 365 East Avenue, to 24 Arnold Park, at Park Avenue, Rochester, N. Y. Practice limited to orthodontia.

Dr. Martin Snyderman announces the opening of offices at 4012 Jenkins Arcade Building, Pittsburgh, Pa. Practice limited to orthodontia.

Dr. Hugh Grun Tanzey, Suite 508 Commerce Building, Kansas City, Mo., announces the opening of a suburban office in the Tower Building, Country Club Plaza, Mill Creek Blvd., at 47th Street, January 15th, 1925. Helen R. Stahle, associate, graduate of International School of Orthodontia. Practice limited to orthodontia.